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Isotropea. [Original composition]

Strunk, Michael Joseph, M.A.

San Jose State University, 1992

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ISOTROPEA

A Thesis

Presented to

The Faculty of the Department of Music

San Jose State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

by

Michael Strunk

December, 1992

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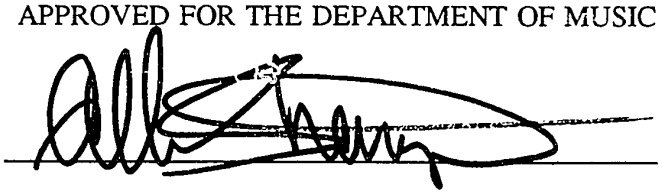

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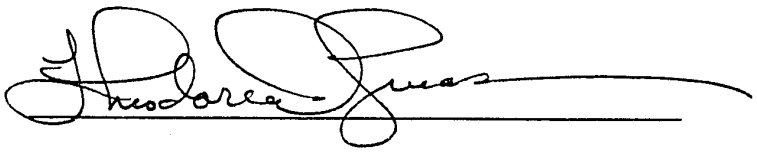

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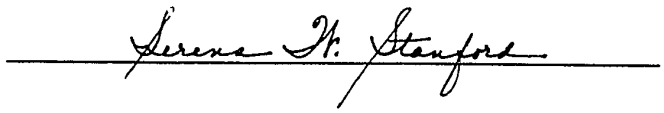


ABSTRACT

ISOTROPEA

by

Michael Strunk

This thesis is a musical composition scored for three percussionists, piano, and string quartet. It explores, through musical means, the symmetry operations found in three-dimensional ordered solid objects that are isometric in character. These symmetry operations are expressed in the music predominantly by thematic transformation using compositional techniques such as retrograde, inversion, retrograde inversion, and mirror imaging.

Introduction

Isotropea is a set of musical episodes exploring symmetric transformations of a theme. These transformations are derived from the use of basic compositional operations such as retrograde, mirror imaging, inversion, and retrograde inversion. In *Isotropea*, specific combinations of these symmetry operations are grouped together in order to mimic combinations found in three-dimensional ordered solid objects, commonly known as crystals.

A crystal can be defined as any "homogeneous solid possessing long-range, three-dimensional internal order" (Dana, 1977). The internal order of crystals, generated by their molecular structure, can be explained by the use of geometrical patterns called *operations*. The operations found in homogeneous solids are translation, rotation, mirror plane, center of inversion, and rotational inversion. Translation is the sole linear, or one-dimensional operation; all other operations are two-dimensional. (For an excellent synopsis of symmetry operations, see Smith, 1982.) When two or more of these operations are combined, a three-dimensional imaginary structure is created. For instance, the combination of translation (linear repetition) with rotation about an axis generates a "screw" structure; translation combined with a mirror plane produces a "glide" structure commonly seen in human footprints (Dana, 1977). In crystal structures, rotation and rotational inversion operations are limited to reproducing motifs at certain intervals within a revolution about an axis. A one-fold axis of rotation reproduces a motif once each revolution; a two-fold axis reproduces a motif

every 180 degrees; a three-fold axis, every 120 degrees; a four-fold axis, every 90 degrees; and a six-fold axis, every 60 degrees. Other types of rotational axes (e.g., five-fold or seven-fold) will not produce a solid, homogeneous structure (Dana).

Each of these five rotational operations has a rotational inversion counterpart, which means the motif is inverted each time it is reproduced by a turn of the axis. When these five rotation and five rotational inversion axes are combined with the other symmetry operations mentioned above, the result is a finite number of "classes" of combinations of symmetry elements. These classes can be arranged in an order of increasing symmetrical complexity and by the number of symmetry operations each class possesses. For instance, the *pedial* class contains only one axis of one-fold rotation, exhibiting the lowest order of symmetry possible; the *hexoctahedron* class possesses the highest order of symmetry, with three axes of four-fold rotation, four axes of three-fold rotation, six axes of two-fold rotation, and nine mirror planes.

The hexoctahedron class is one of the five symmetry classes that are *isometric* in character, meaning they possess three mutually perpendicular directional axes that are equal in length (Dana). The isometric classes have the highest symmetry of all the crystal classes, possessing both three-fold and four-fold axes of rotation. *Isotropea* uses three of these classes or shapes: a hextetrahedron, possessing three axes of four-fold rotational inversion, four axes of three-fold rotation, and six mirror planes; a tetartoid, possessing three axes of two-fold rotation and four axes of three-fold rotation; and a hexoctahedron, described above. (An earlier composition by this

author, *Symmetry Suite for Solo Percussion* [1987], explores other non-isometric shapes).

One of the challenging aspects of composing this music has been the attempt at portraying a three-dimensional object using essentially a two-dimensional medium: pitch (frequency) and rhythm (time). In composing *Isotropea,* the method chosen to portray this effect is one that is analogous to a cylinder rolling across a table-top. The line where the cylinder meets the table or plane surface is the musical moment. In this case, an imaginary "musical crystal" is revolving in front of the listener; as the rotations continue, different musical patterns are presented to the listener in a similar way as light is reflected off the different faces of a rotating crystal. This rotation is not always centered about one axis; the axes change as each musical episode develops. For the hextetrahedron and tetartoid shapes, three different rotational axes are used in the music. The final shape, hexoctahedron, uses only one axis (see the analysis below). The motif for all of these musical shapes is a single melodic theme of six notes, first exposed in its original form by the cello in measures 112-113 (see example 1a). This theme is slightly lengthened to eight notes in the final octahedron section of the music, as played by the cello in mm.469-470 (example 1b).

Analysis

Isotropea is written in three movements, played continuously, with each movement corresponding to a specific isometric shape. The first movement, mm.1-

313, is a tetrahedron; the second movement, mm.314-461 is a tetartoid; and the final movement, from measure 461 to the end, is an octahedron. Each movement is further divided into three parts, resulting in a total of nine sections. In movements one and two, the separate sections are based upon changes in rotational orientation of the musical shape. In movement three, however, the separation is achieved through other compositional factors such as tempo and structure. Throughout the entire work, various symmetrical scales or pitch collections are used as melodic material in an effort to accentuate the symmetrical nature of the music. All scales are centered around the pitch 'e^{1}', effectively making this pitch the tonal center of symmetry for the entire composition. The first section of the first movement (mm.1-117) is written entirely in B-flat Dorian mode, produced by combining two tetrachords, b^{b}-c-d^{b}-e^{b} and f-g-a^{b}-b^{b}, on either side of the pitch 'e'. The middle section (mm.118-185) shifts to E Dorian, reflecting the shift from a four-fold rotational axis to a three-fold rotational inversion axis. This modal shift is accompanied by a temporal shift in the repeated phrase length. The first section cycles a four measure phrase in 6/8 meter for a total of twenty-four beats, changing to a six measure phrase in the second section, then returns to a four measure phrase cycle in the third section (mm.186-313). This third section also returns to a B-flat Dorian mode, but with a much wider ambitus than in the first section. The scale material of the second movement (mm.314-461) is based on fourths: b^{b}-e^{b}-f-b^{b} in the first two sections (mm.314-361 and mm.362-409) and b-e-a in the last section (mm.410-461). These scales are accompanied by meters of 7/8,

4/4, and 7/8, respectively. In the final movement, the first two sections (mm.462-471 and mm.472-511) again use two symmetrical tetrachords, b^{b}-c-d-e^{b} and f-g^{b}-a^{b}-b^{b}. These change in the final section to the original B-flat Dorian used at the beginning of the work. The entire final movement is written in 4/4 time with a repeating six measure phrase, representing a three-fold rotational axis.

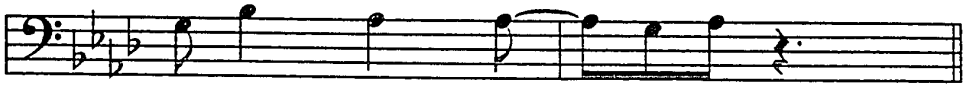
Thematic manipulation is the predominant compositional process in this work. The main theme (example 1a) has been transformed by standard musical techniques commonly found in serial music--retrograde, inversion, and retrograde inversion. These processes provide additional melodic material, and are the result of mirror planes or inversion centers within the musical structure. Example 2a shows a horizontal mirror plane with the resulting retrograde melody; example 2b depicts a vertical mirror plane and the inverted melody; example 2c depicts the retrograde inversion that results from an inversion point occurring at the end of the theme.

Some non-traditional transformations are necessary, however, in order to accurately capture motivic changes found in the various symmetric structures. For example, at times the theme needs to be rotated upward or downward at roughly 30, 45, 60, or 90 degree angles. Example 3a shows the original theme as it appears in measure 242; 3b is the same theme at a 45° angle in mm.281-283. The relative melodic shape has changed due to the "tilting" of the melody, causing what was the second note of the original melody to occur *before* the first. Example 3c is the same theme rotated straight up at a 90° angle. Steeply tilted melodies such as this one have

also provided a great deal of the harmonic material (vertical sonorities) in this composition. Other harmonies have come from simultaneously occurring notes in different melodies.

Musical Examples

Example 1a.



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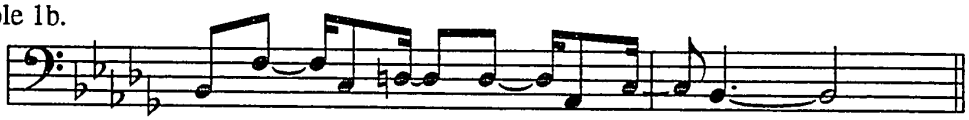

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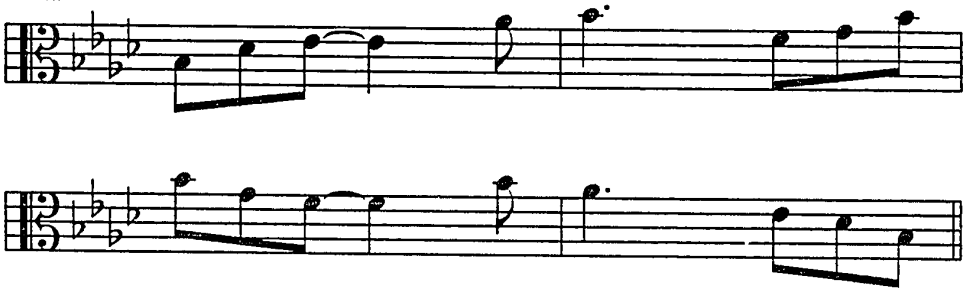

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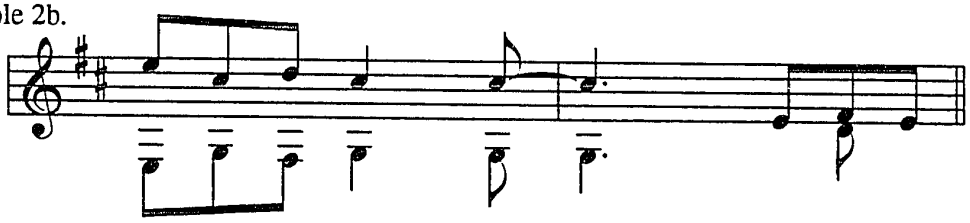

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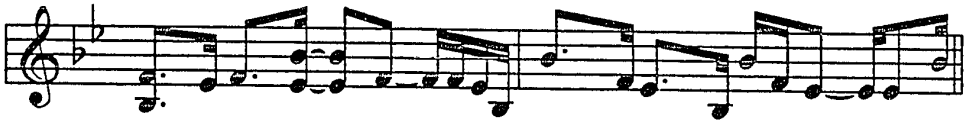

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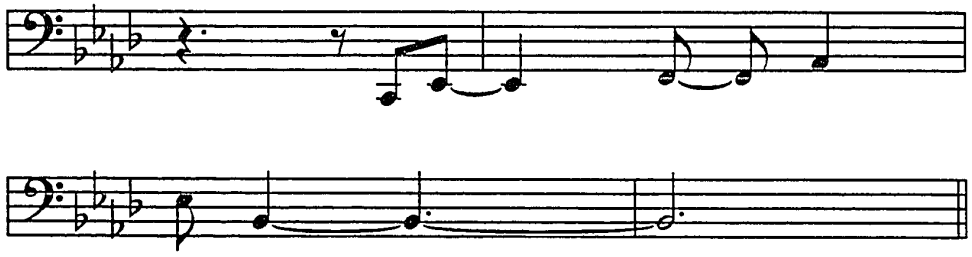

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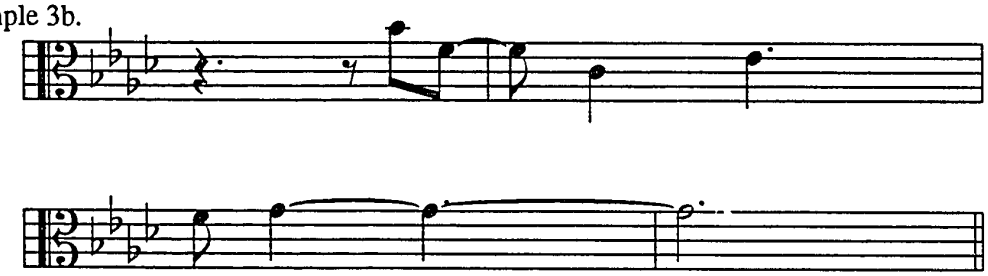

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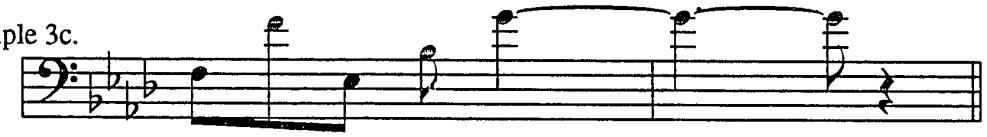

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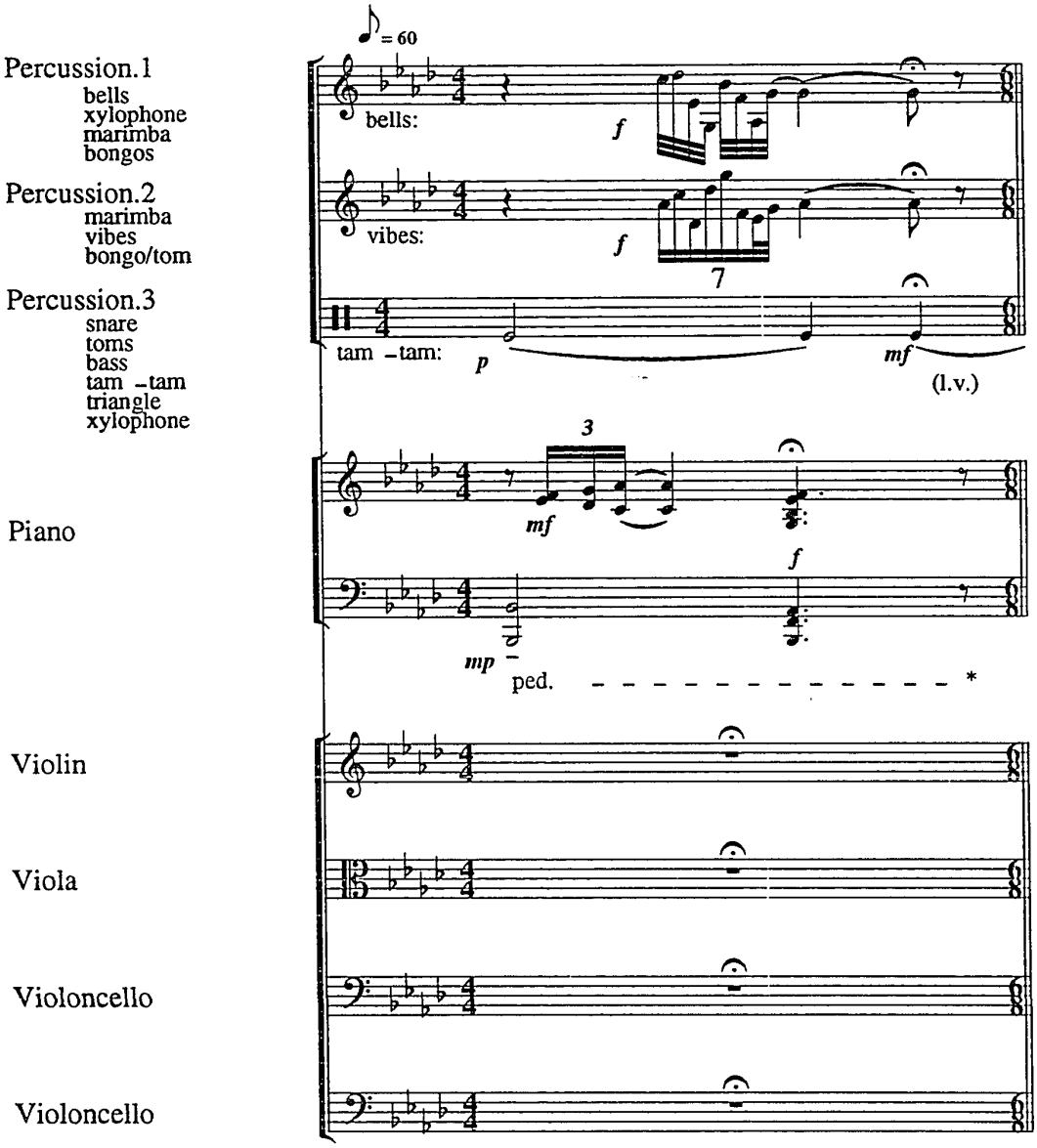

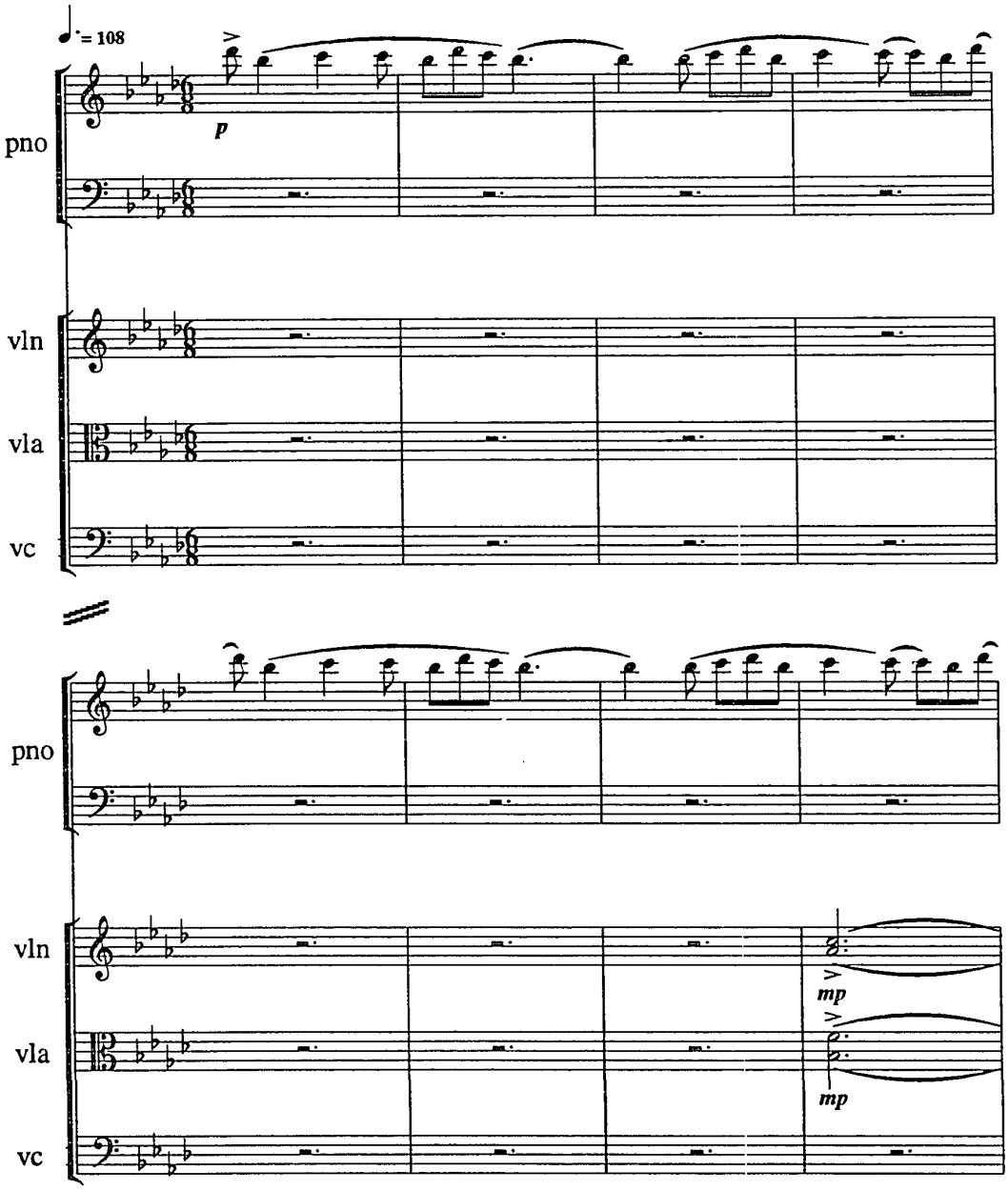
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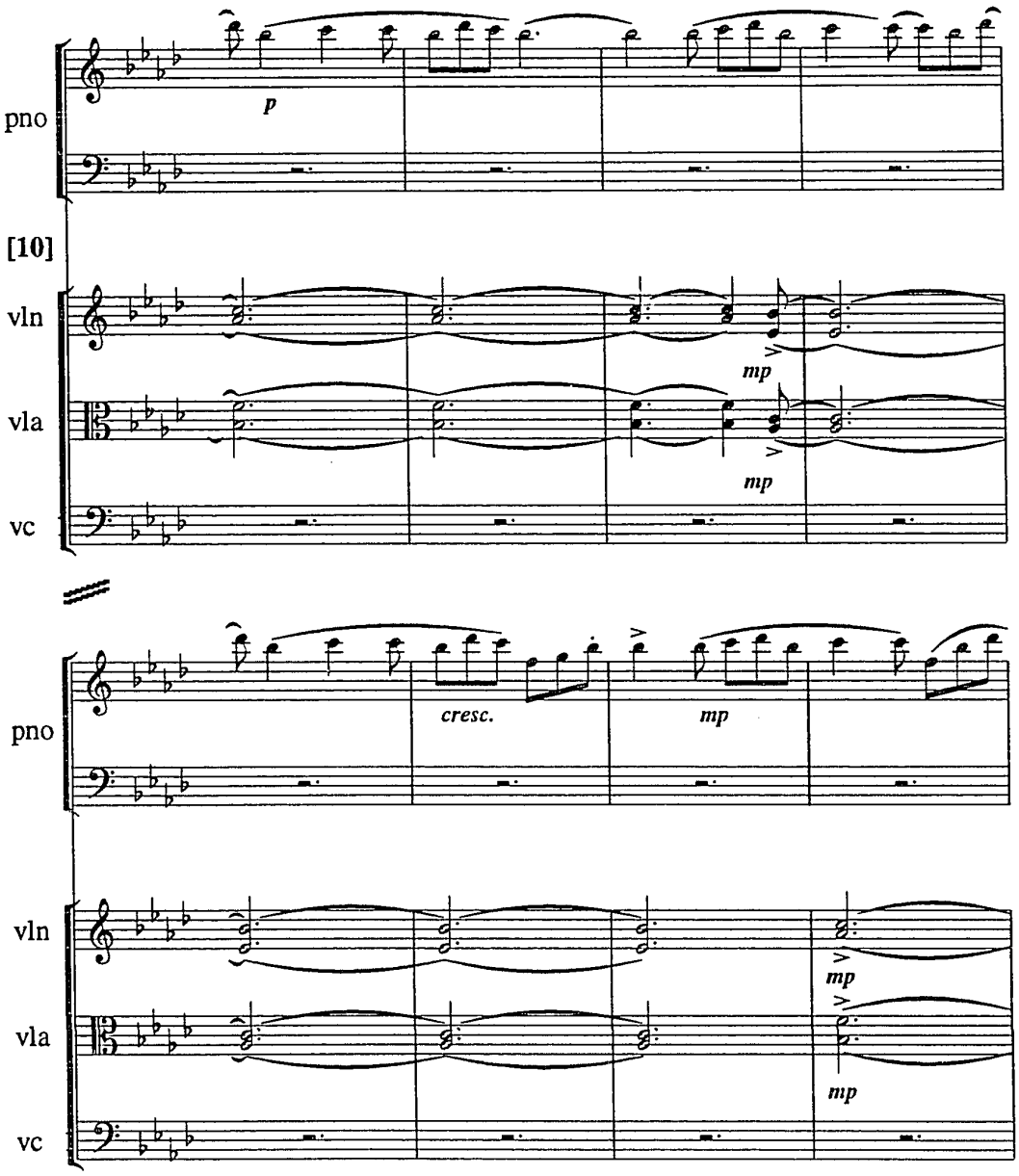
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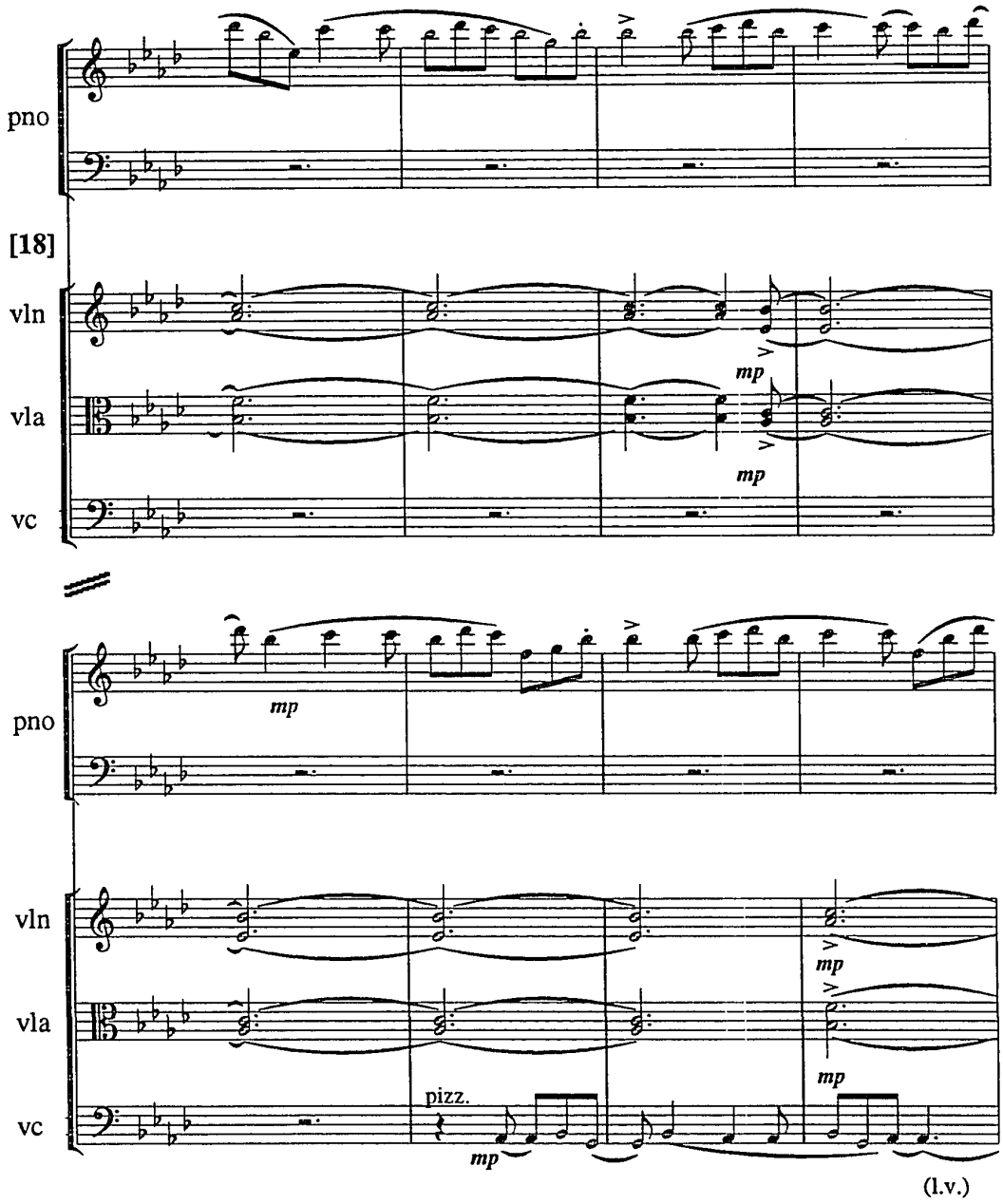
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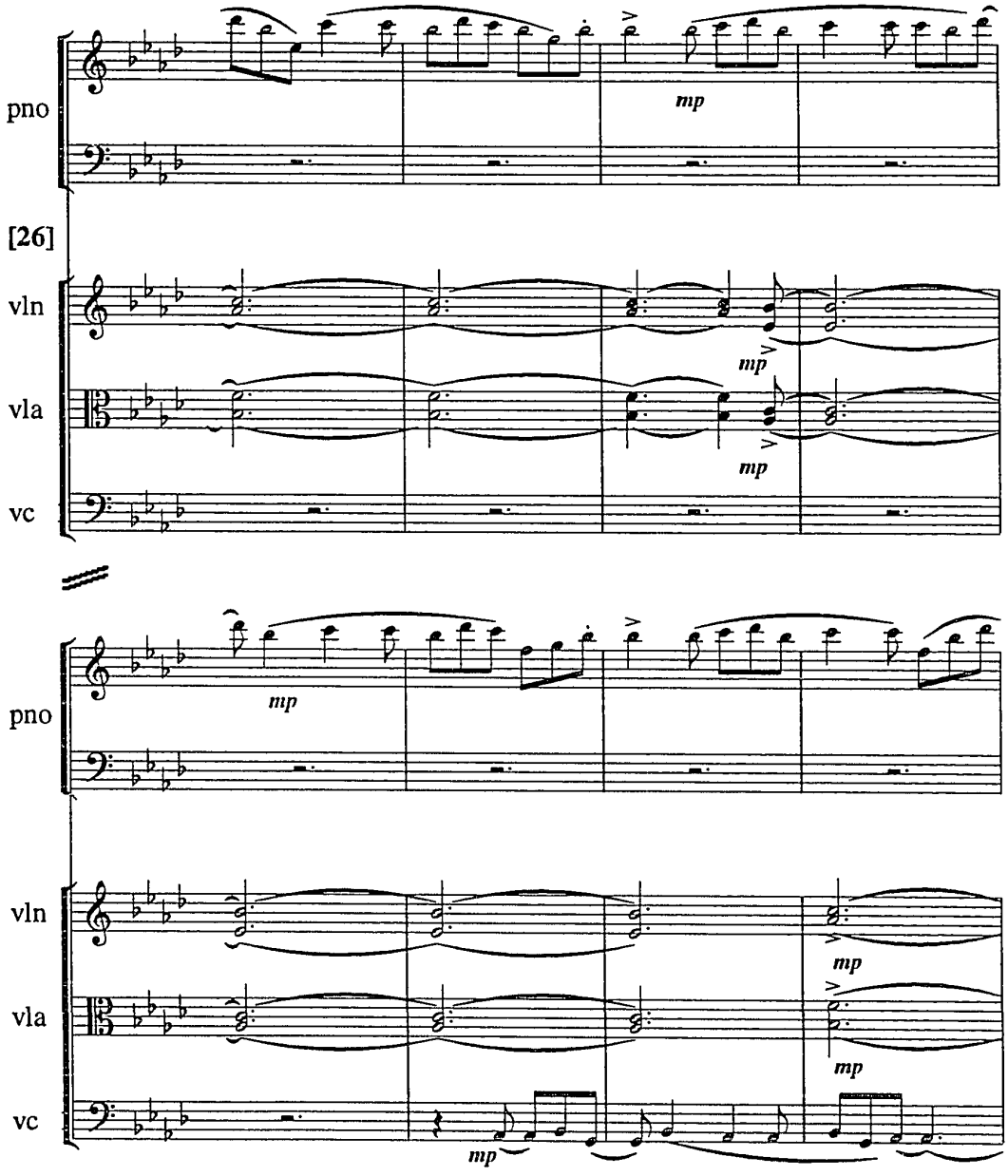
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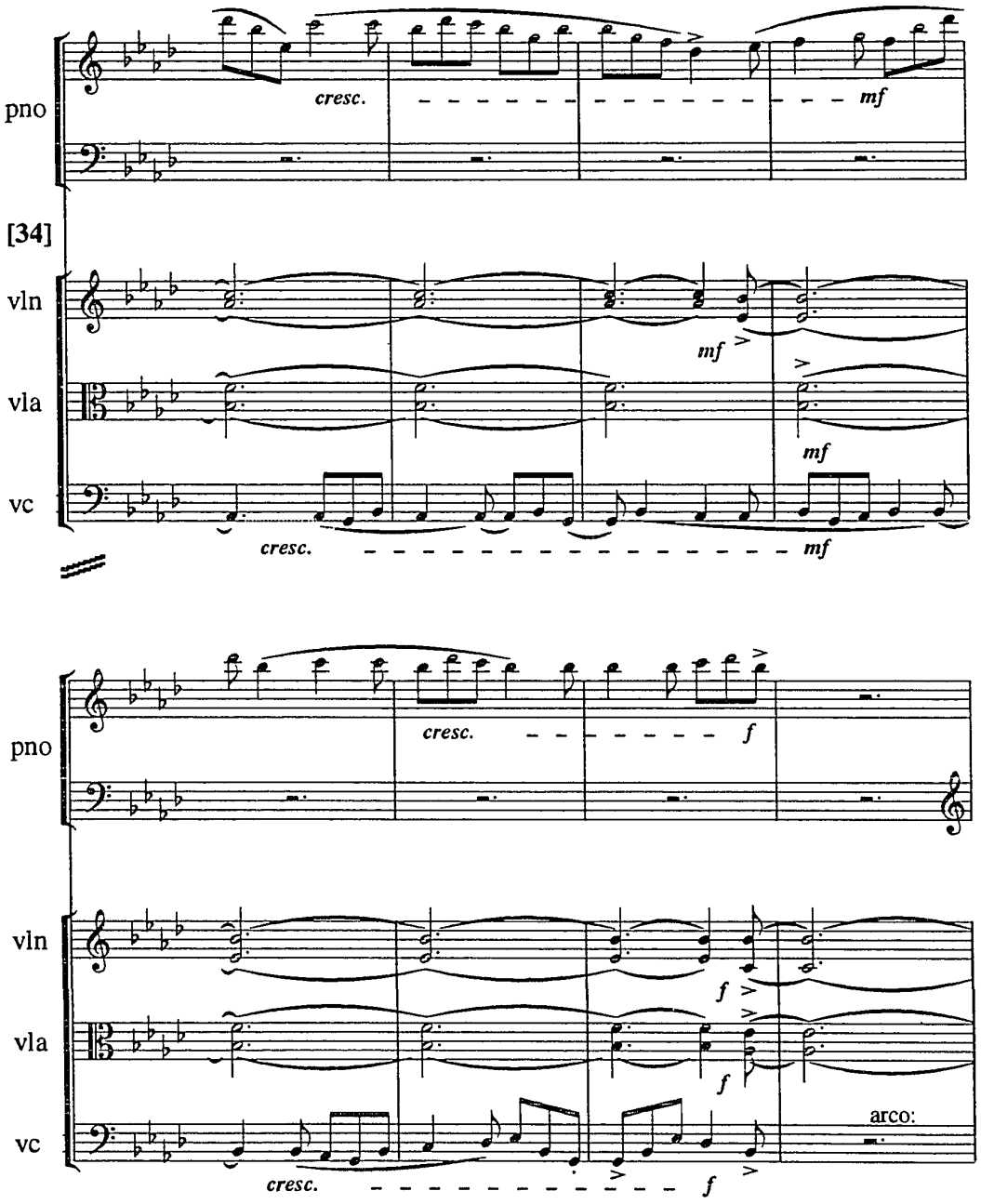
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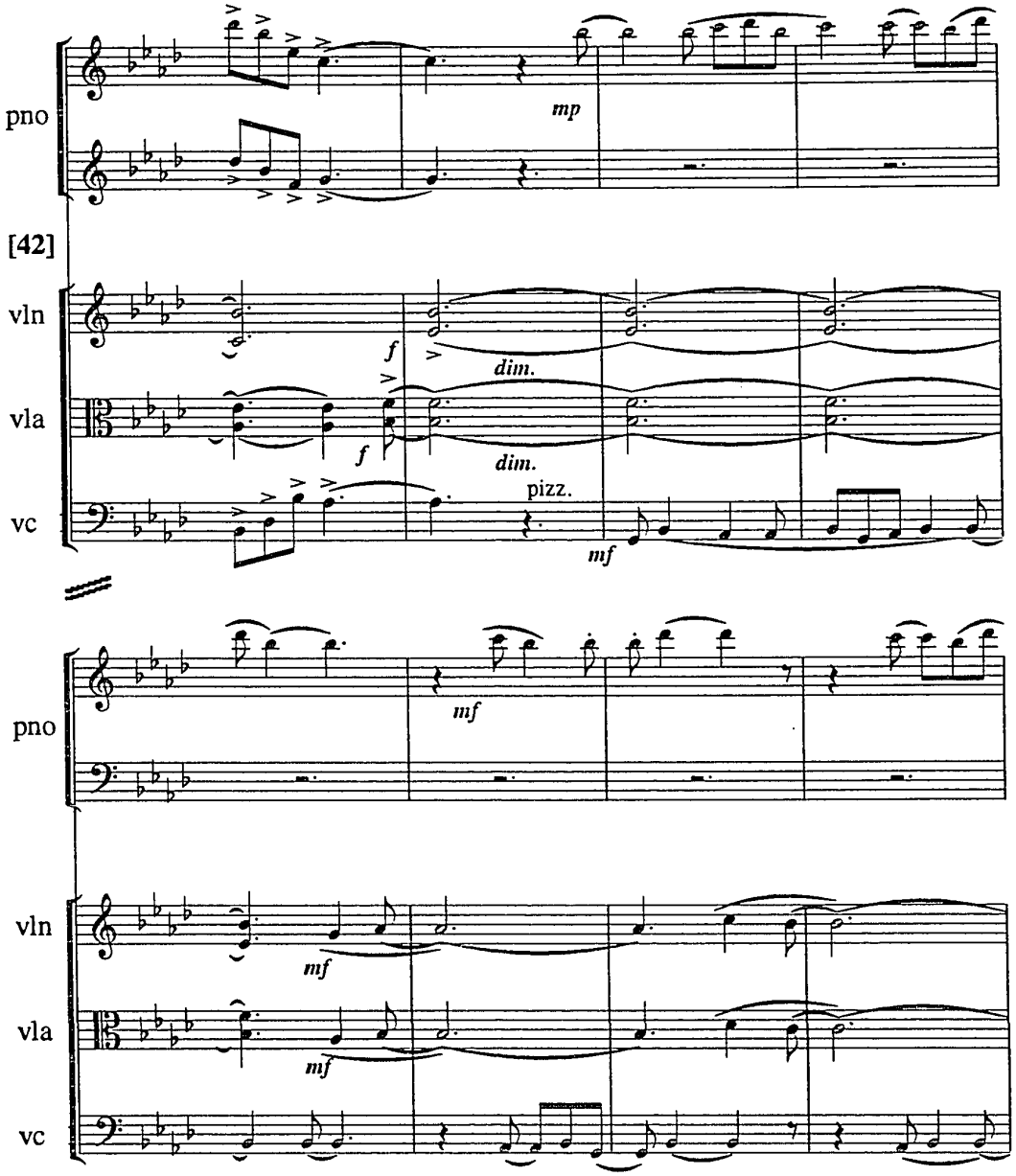
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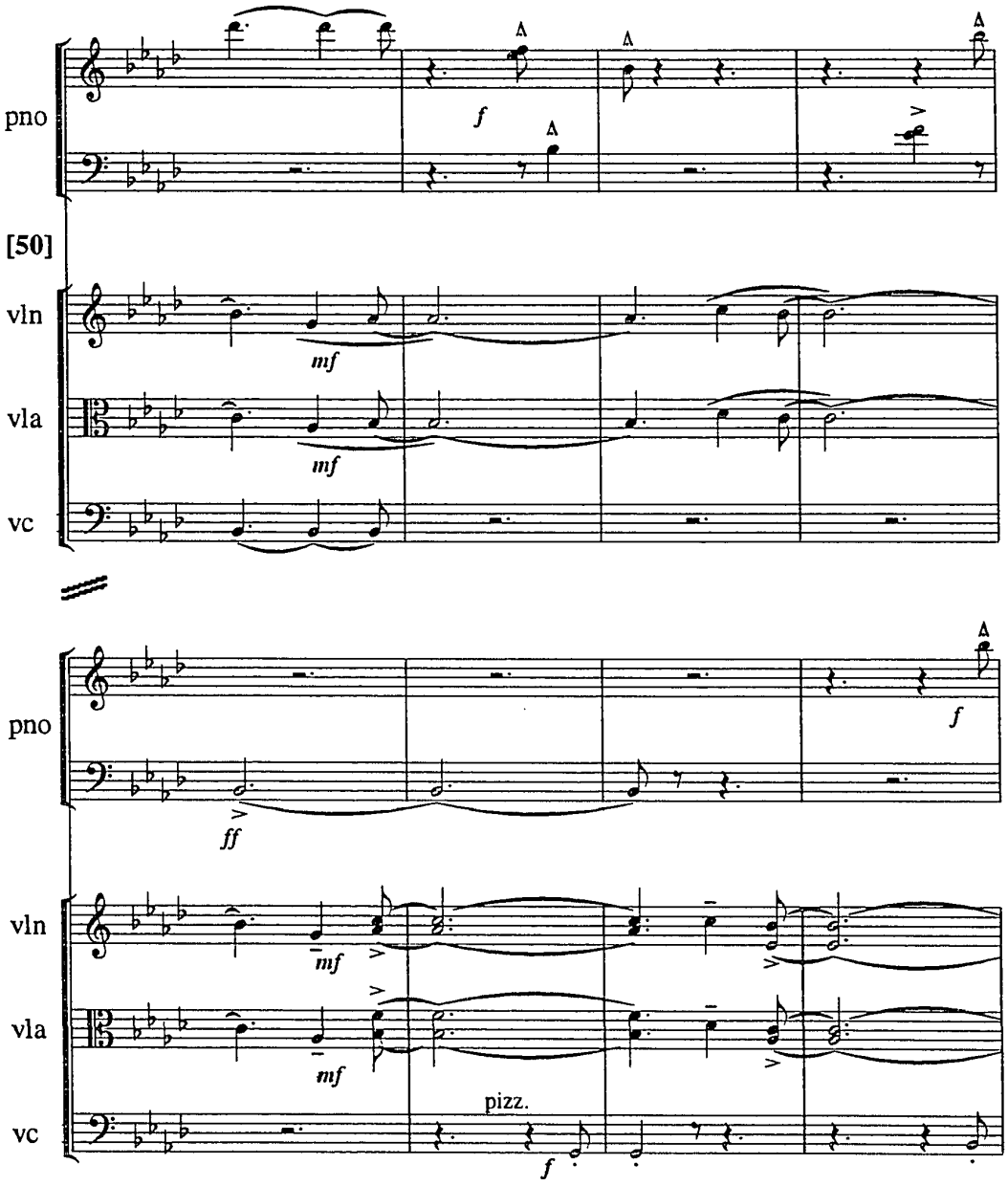
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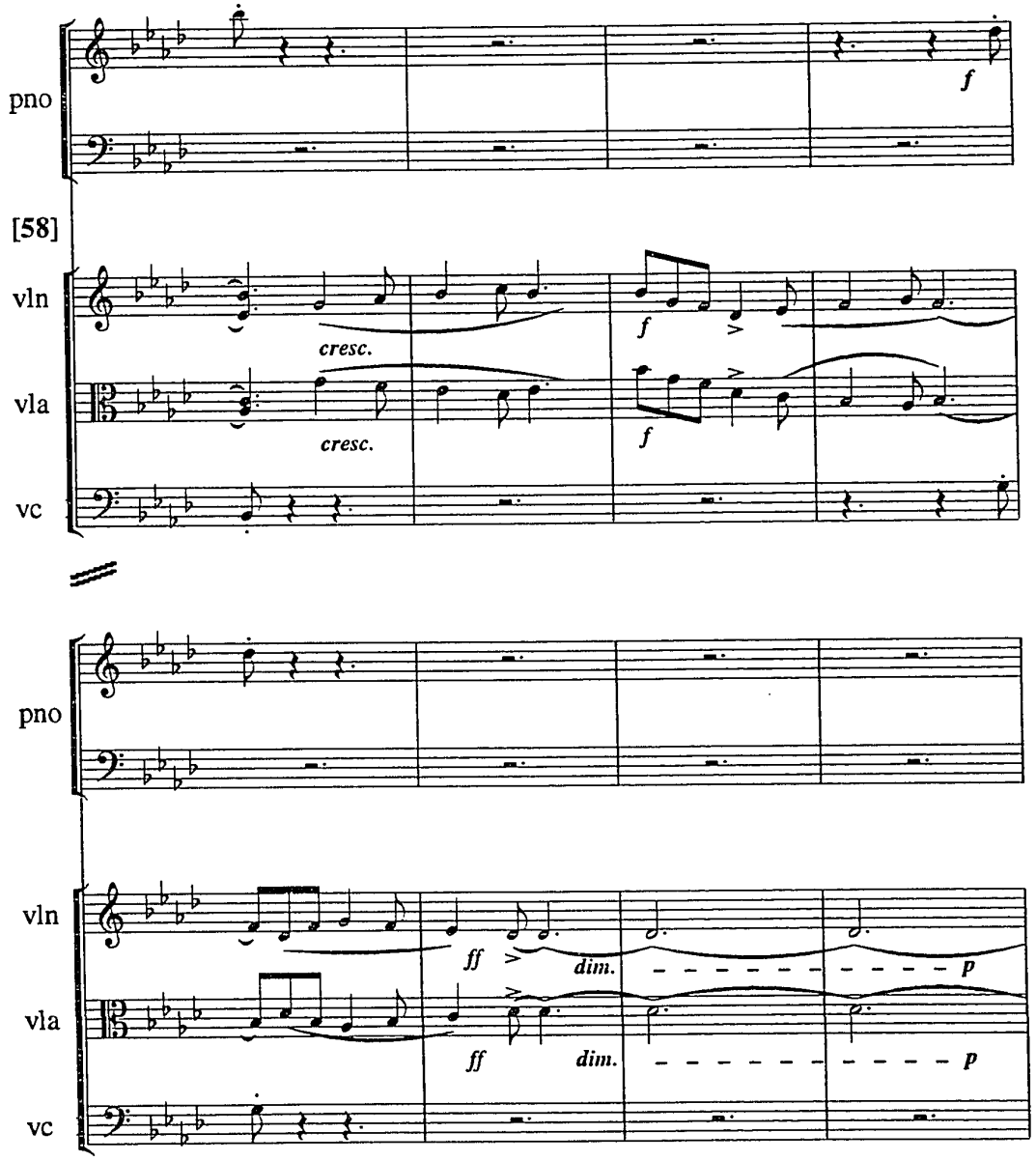
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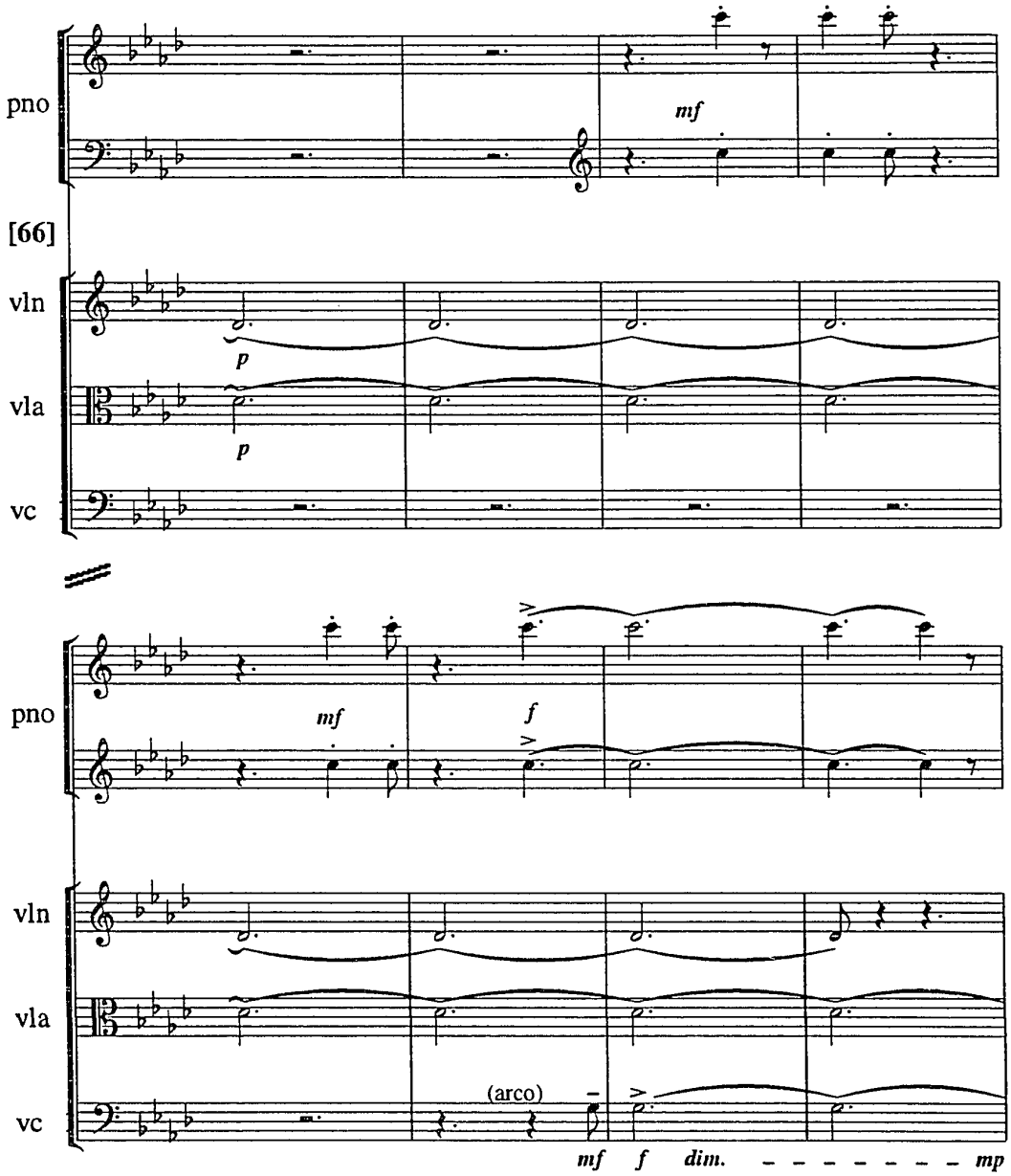
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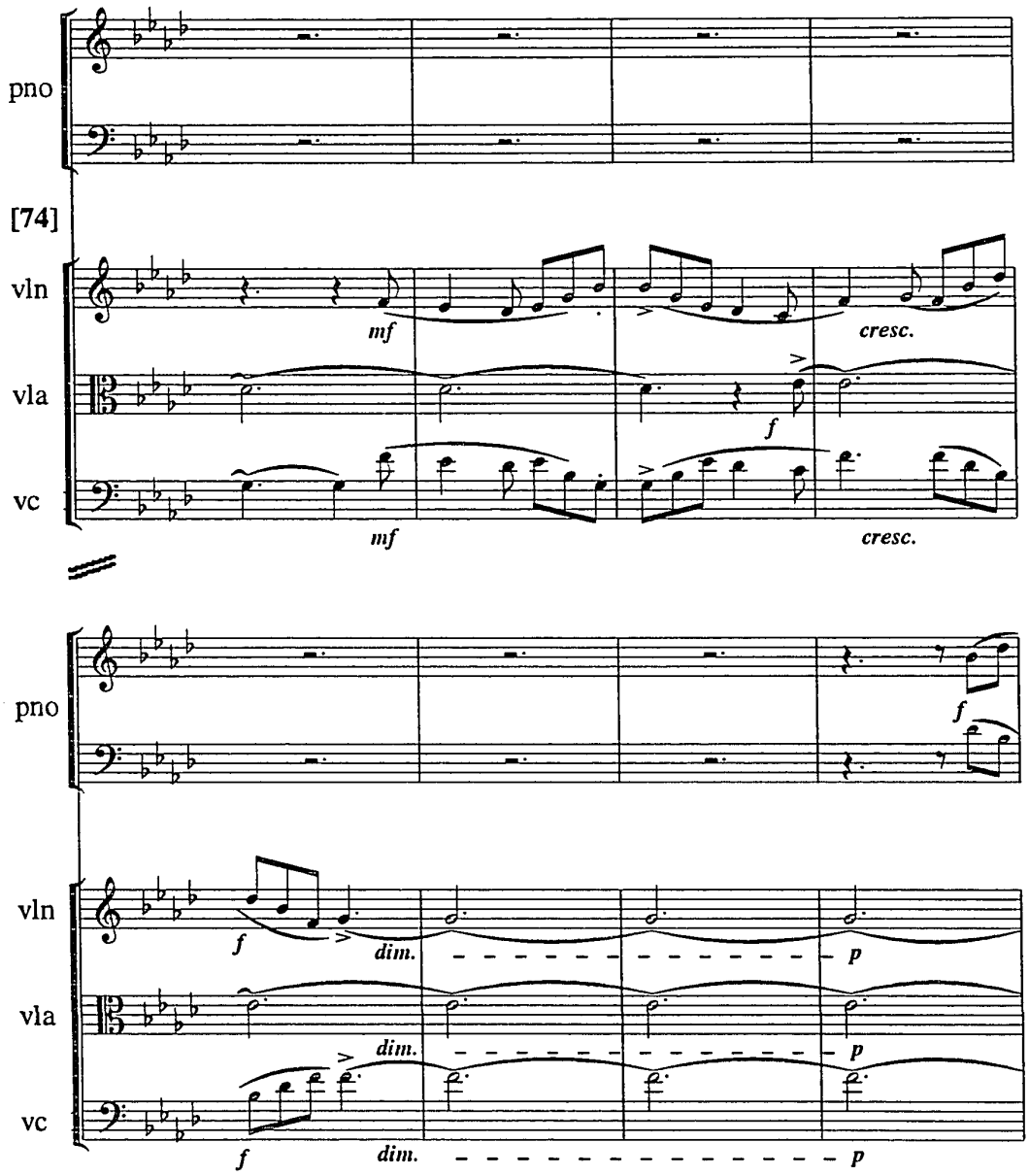
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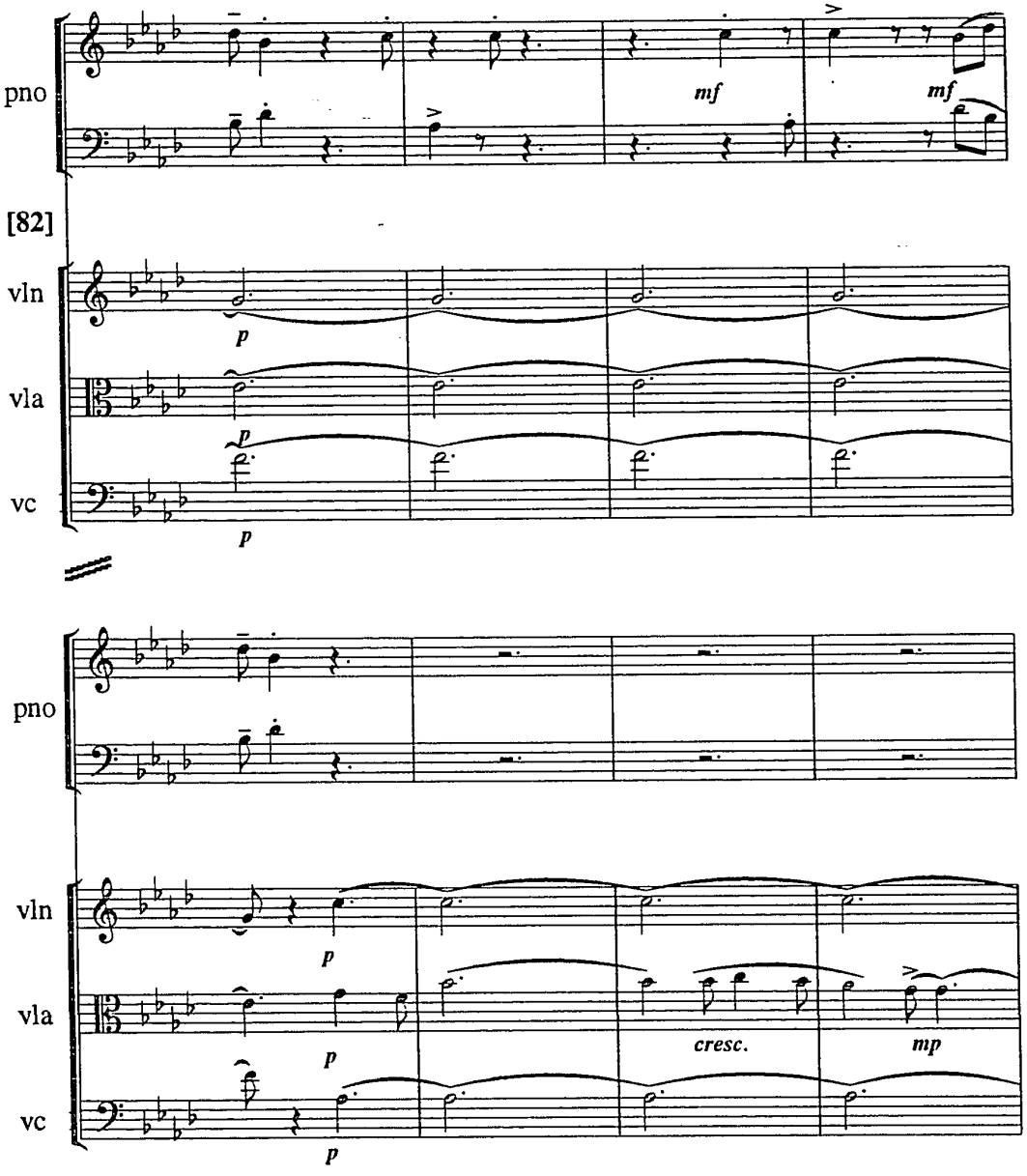
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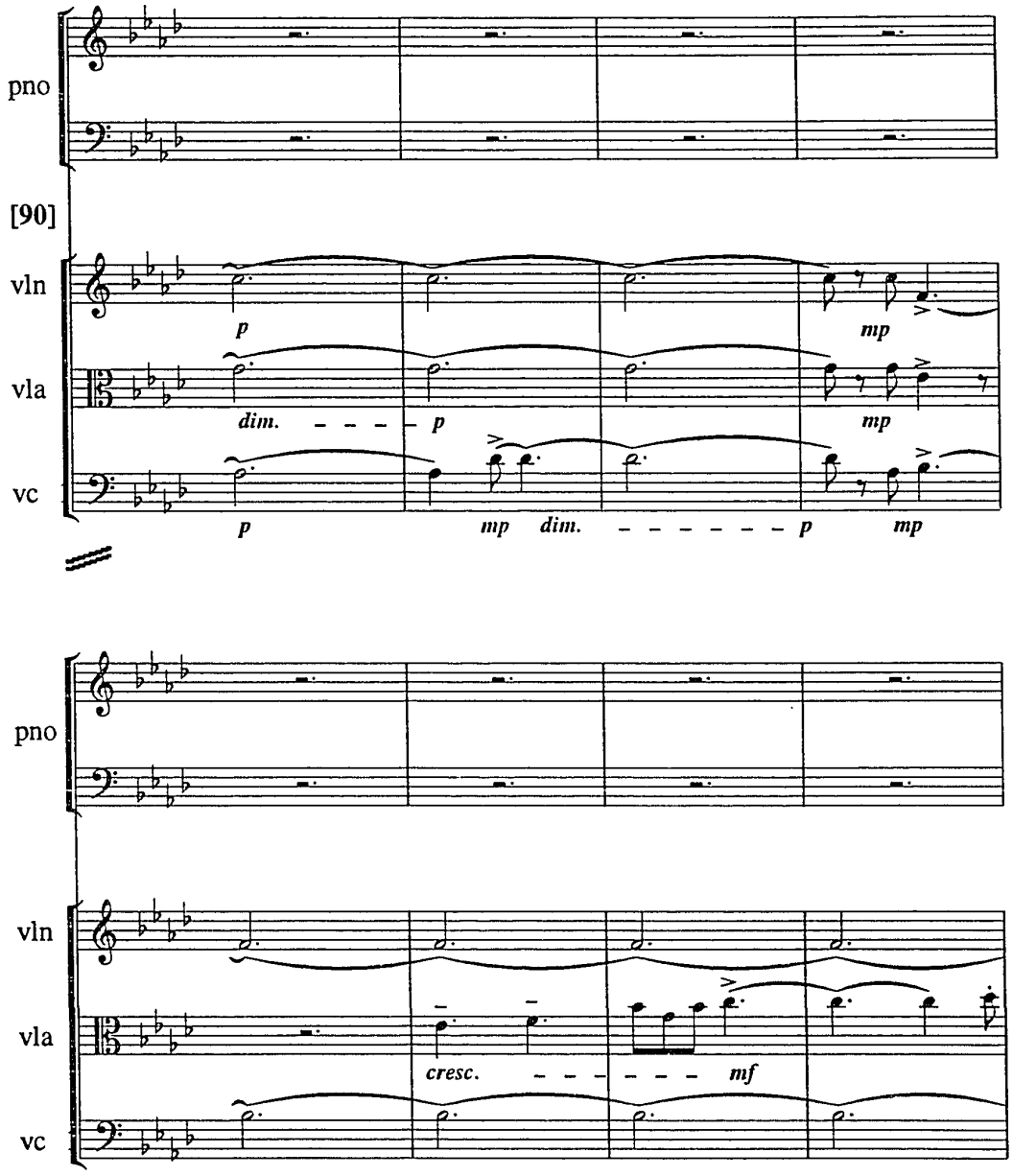
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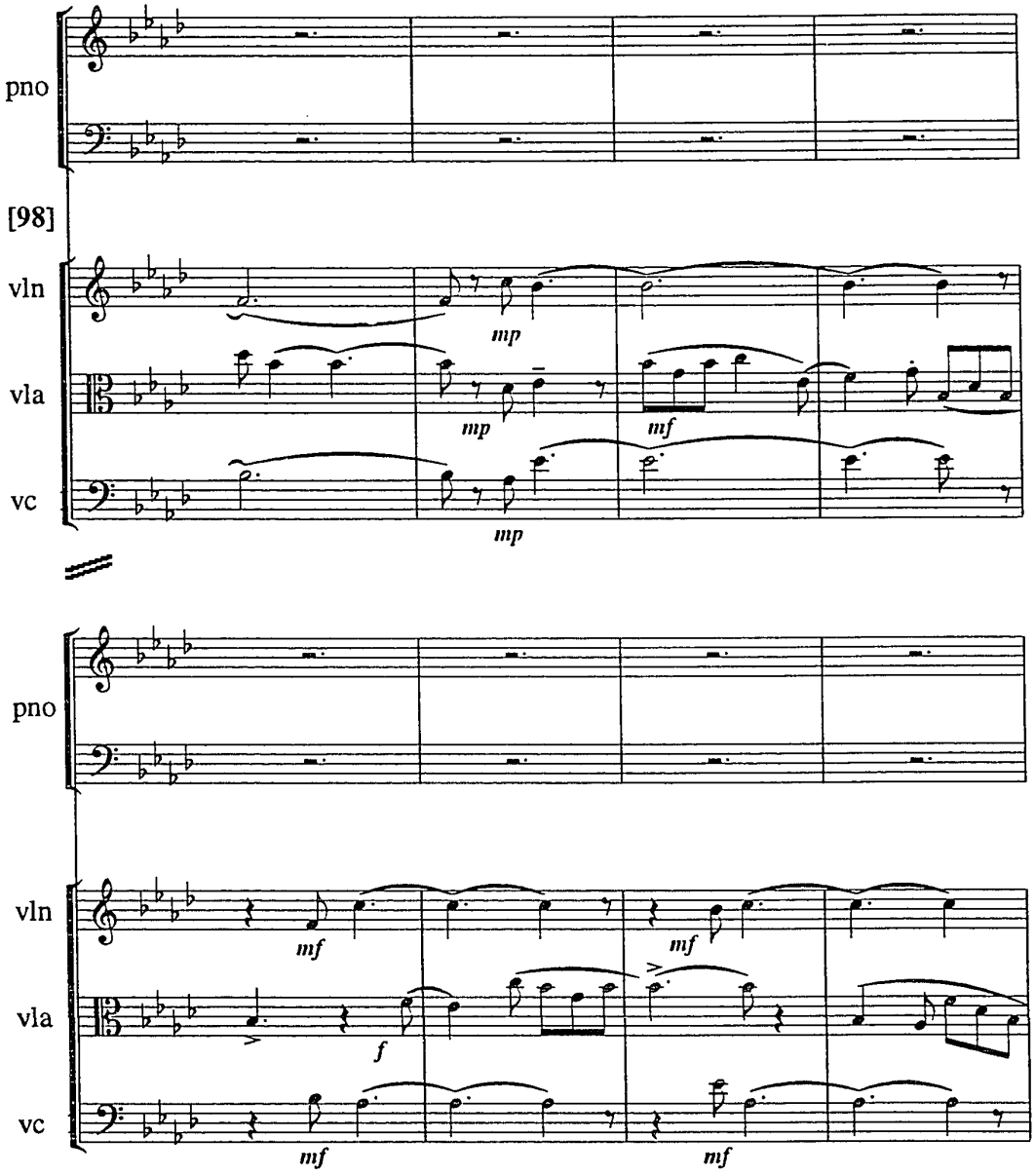
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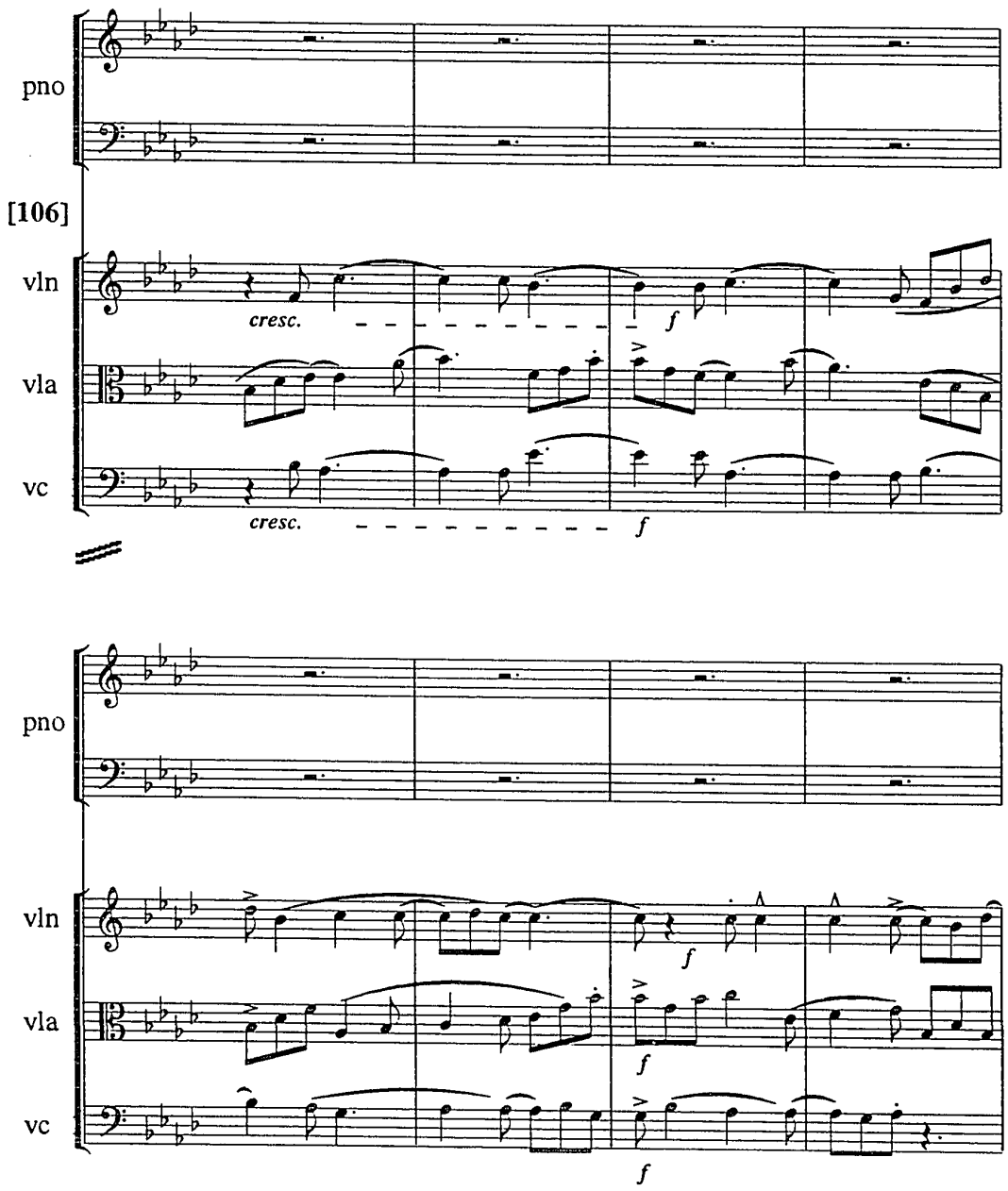
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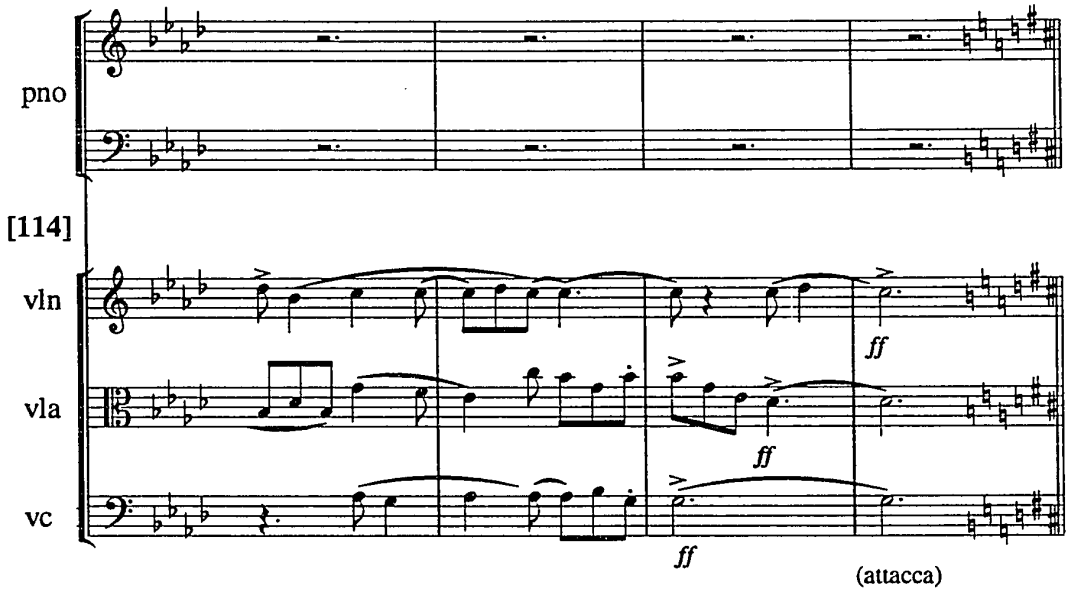
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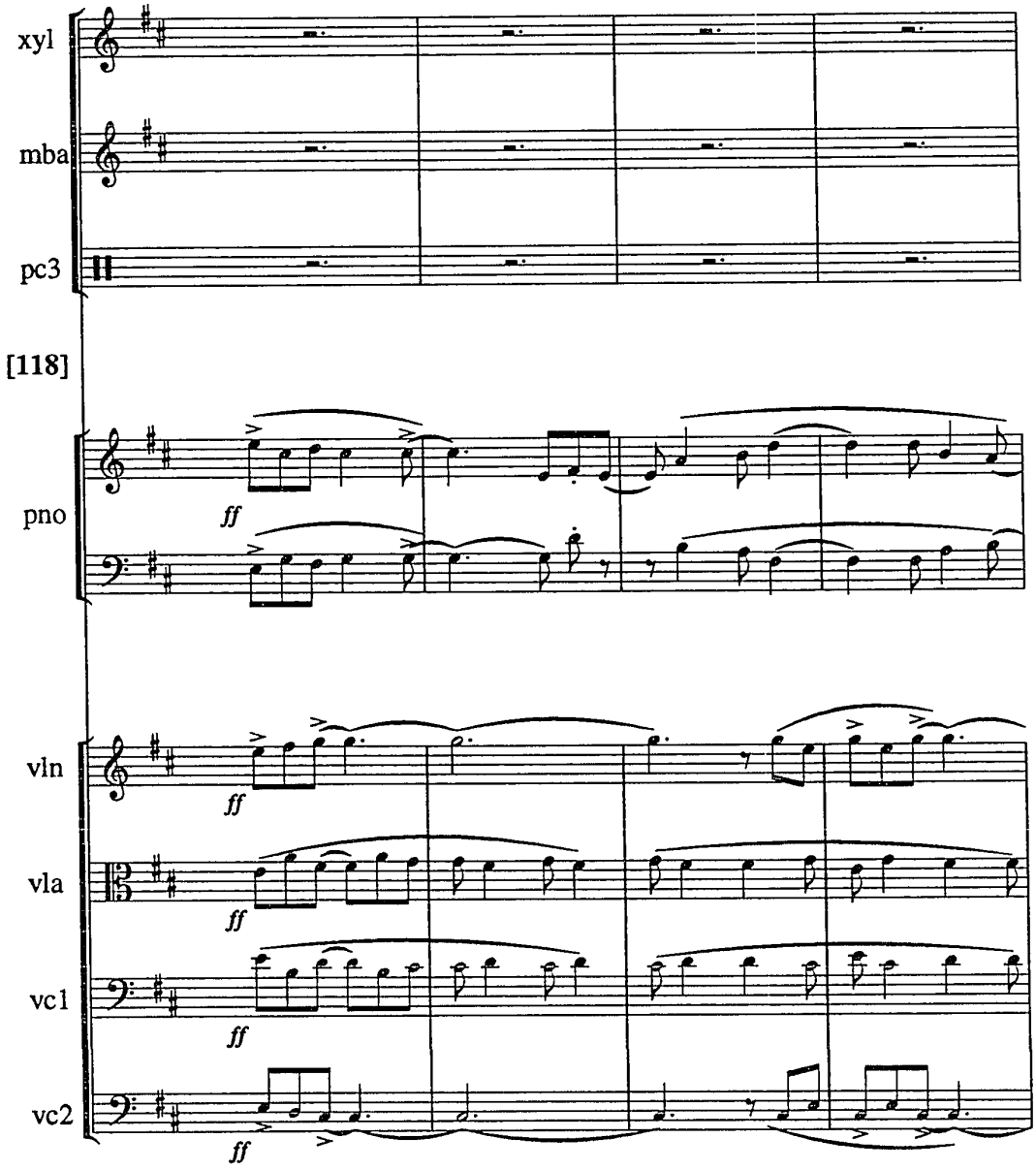
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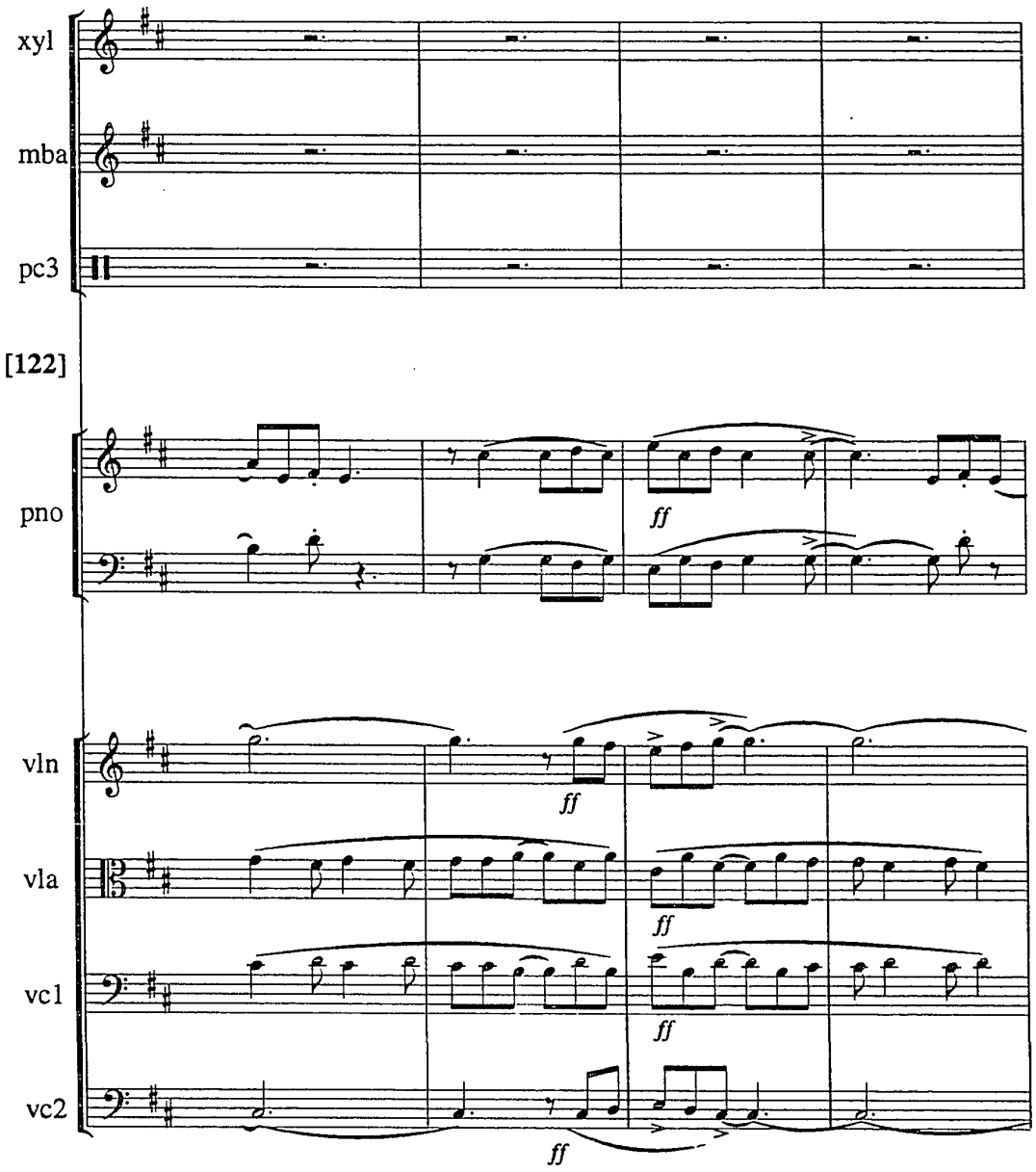
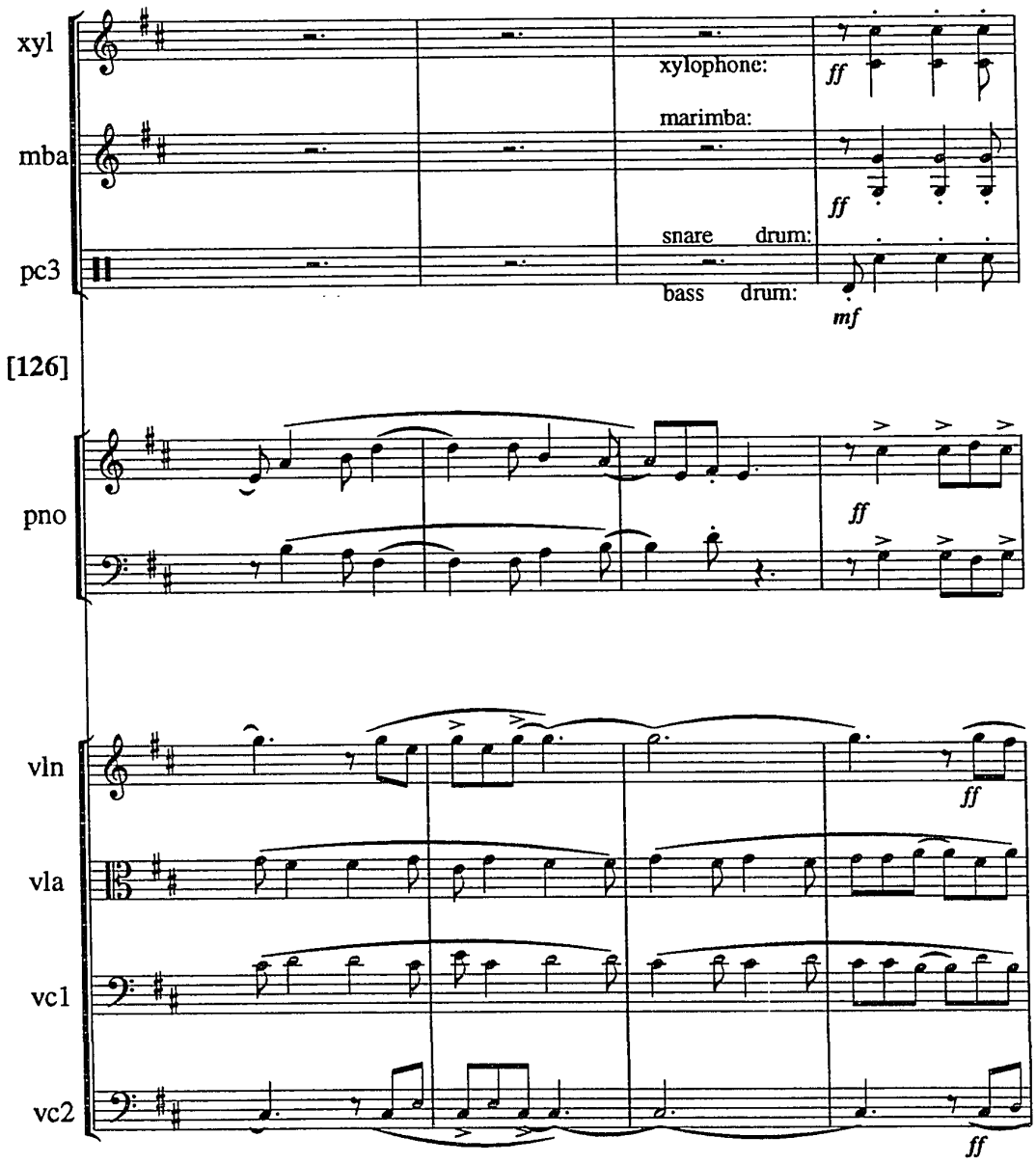
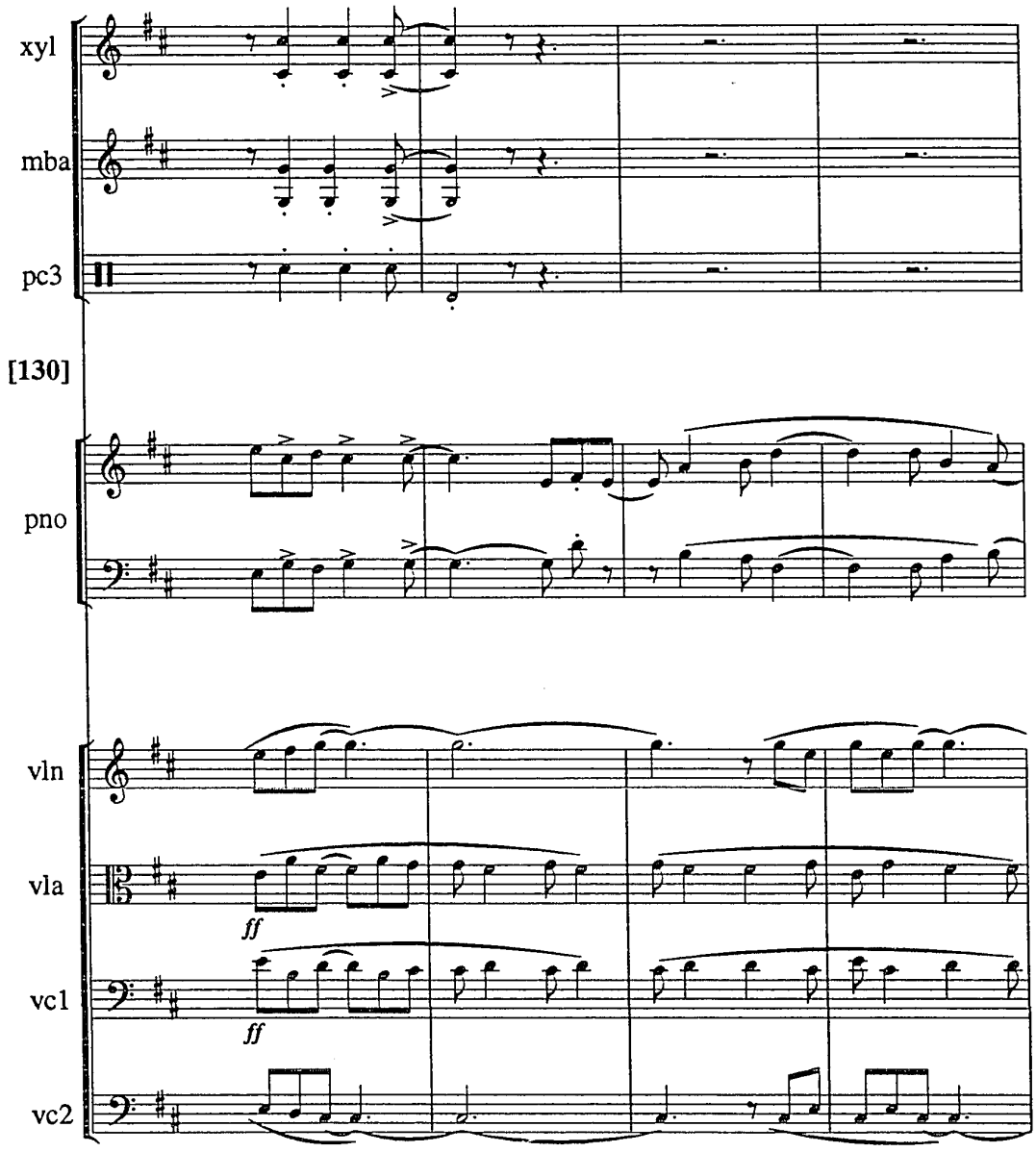
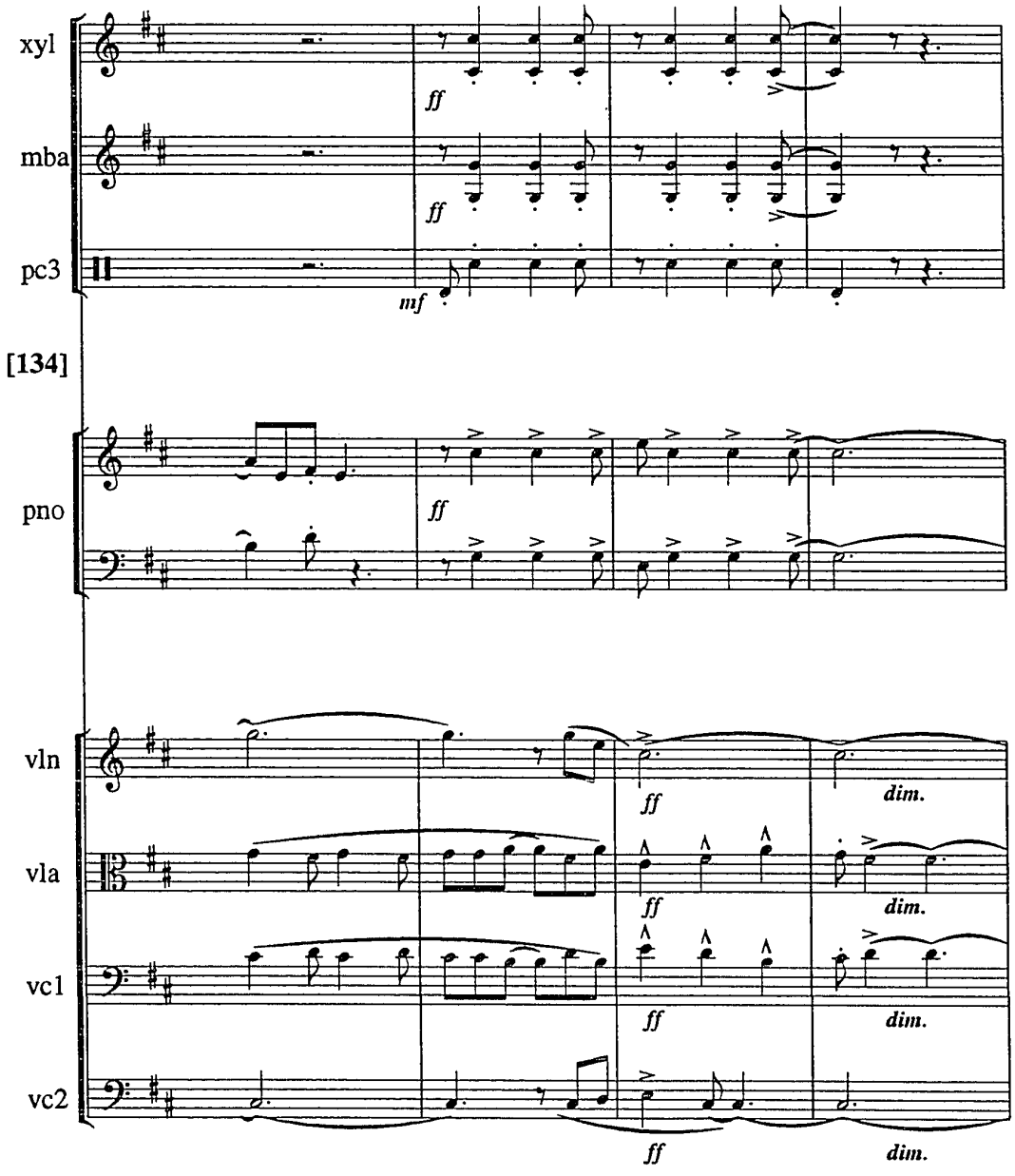
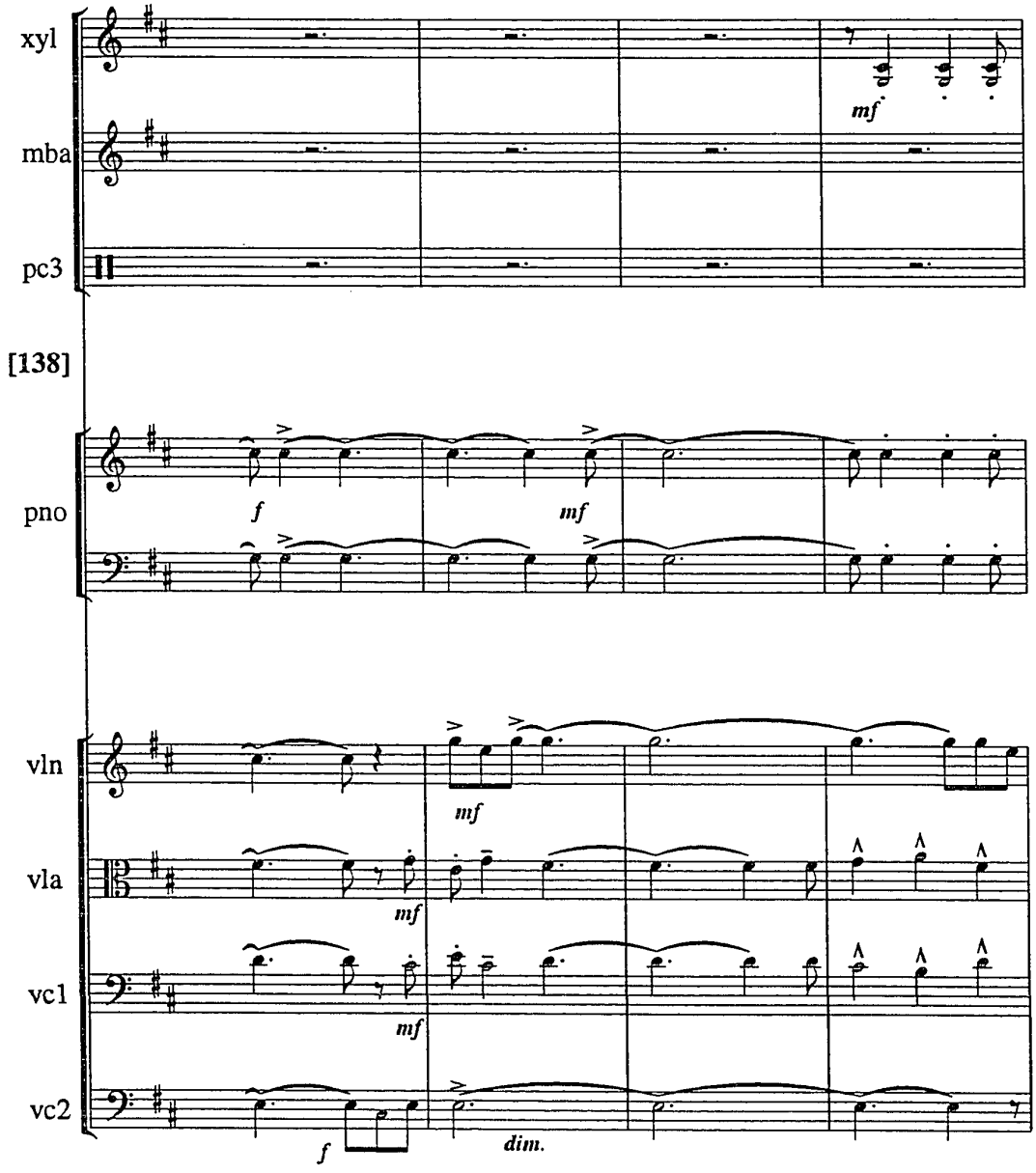
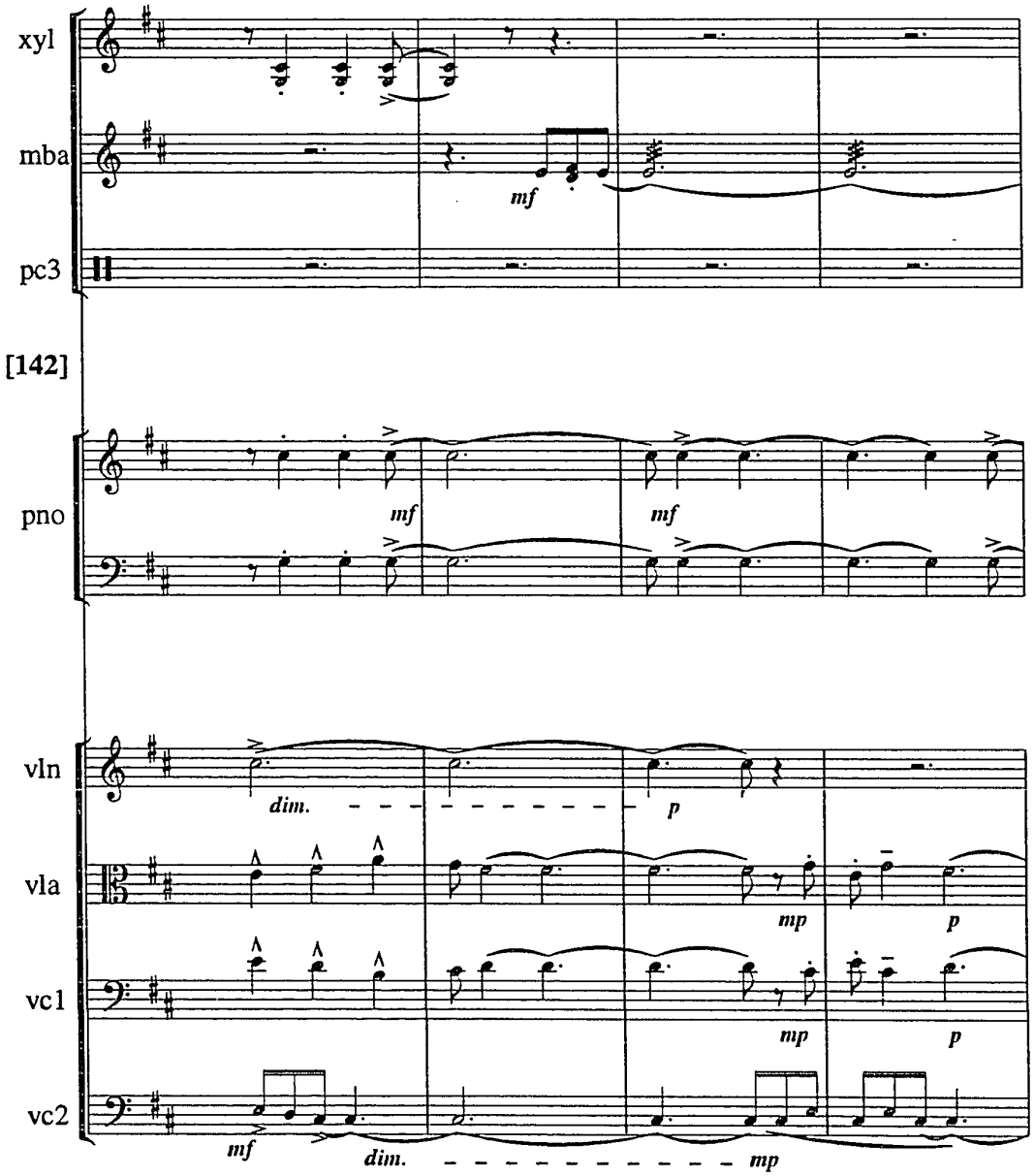

xyl
mba
pc3
[122]
pno
ff
vln
ff
vla
ff
vc1
ff
vc2
ff

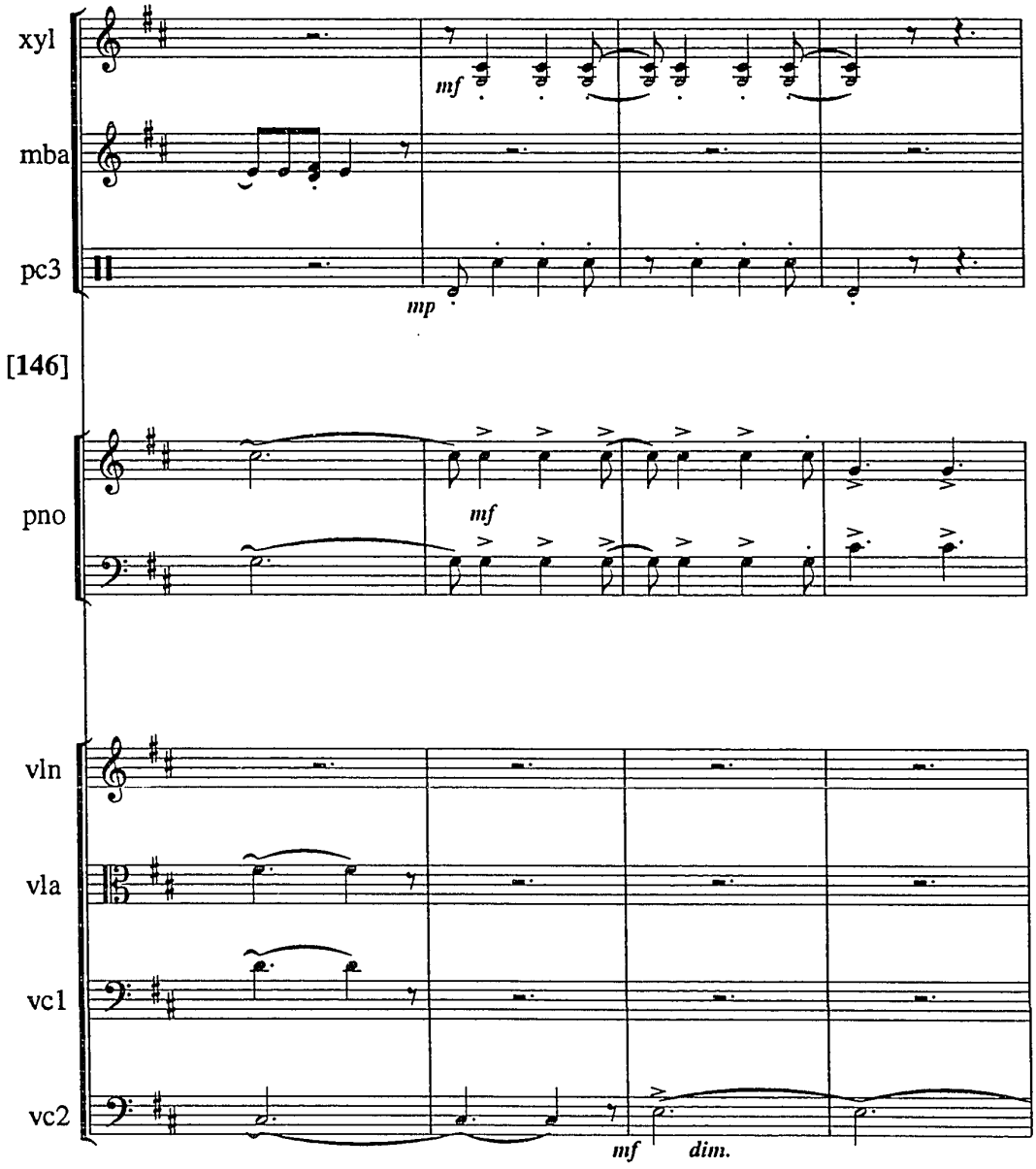

xyl
mba
pc3
xylophone:
marimba:
snare drum:
bass drum:
ff
ff
mf
[126]
pno
ff
vln
vla
vc1
vc2
ff
ff

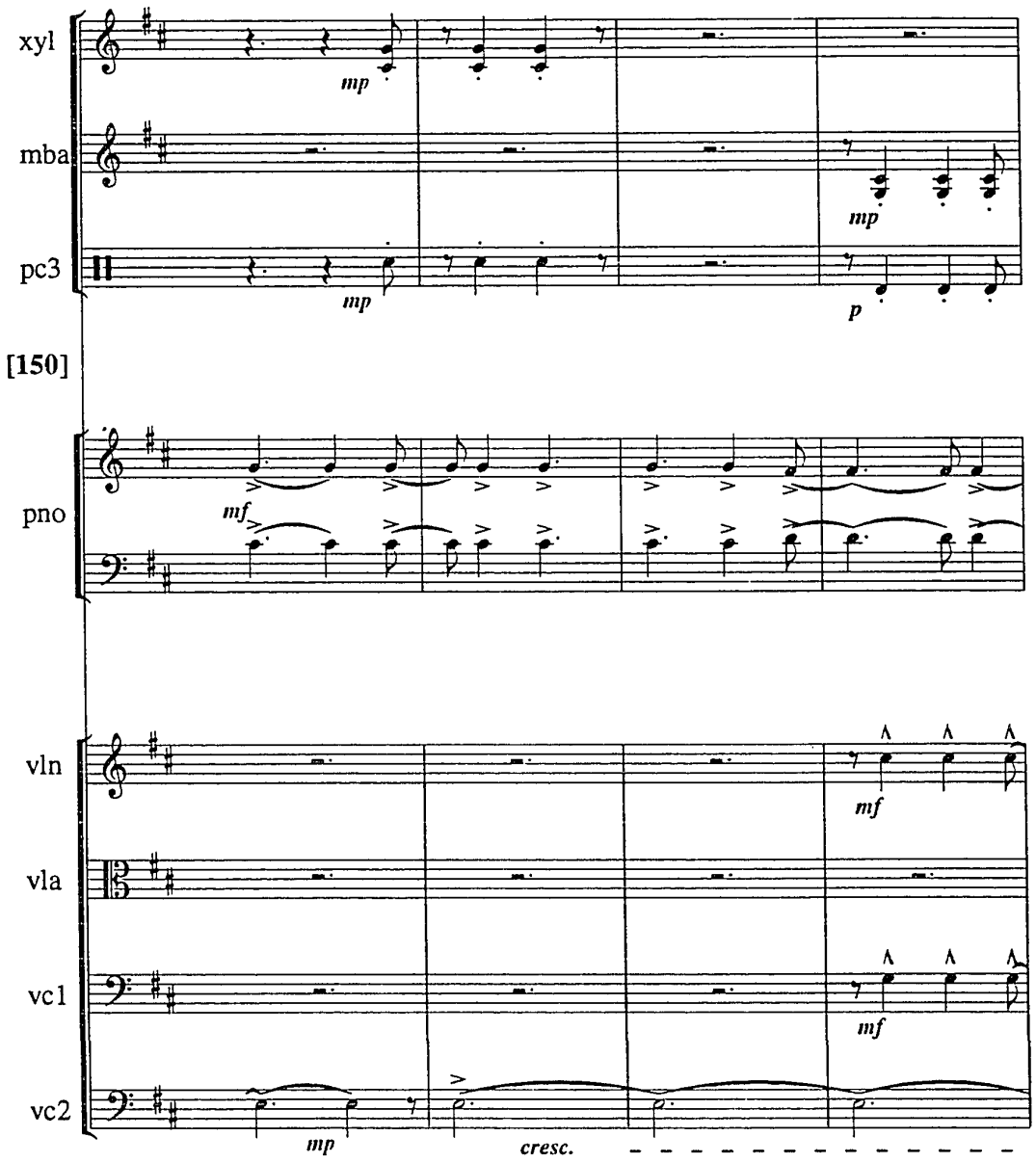

xyl
mba
pc3
[130]
pno
vln
vla
ff
vc1
ff
vc2

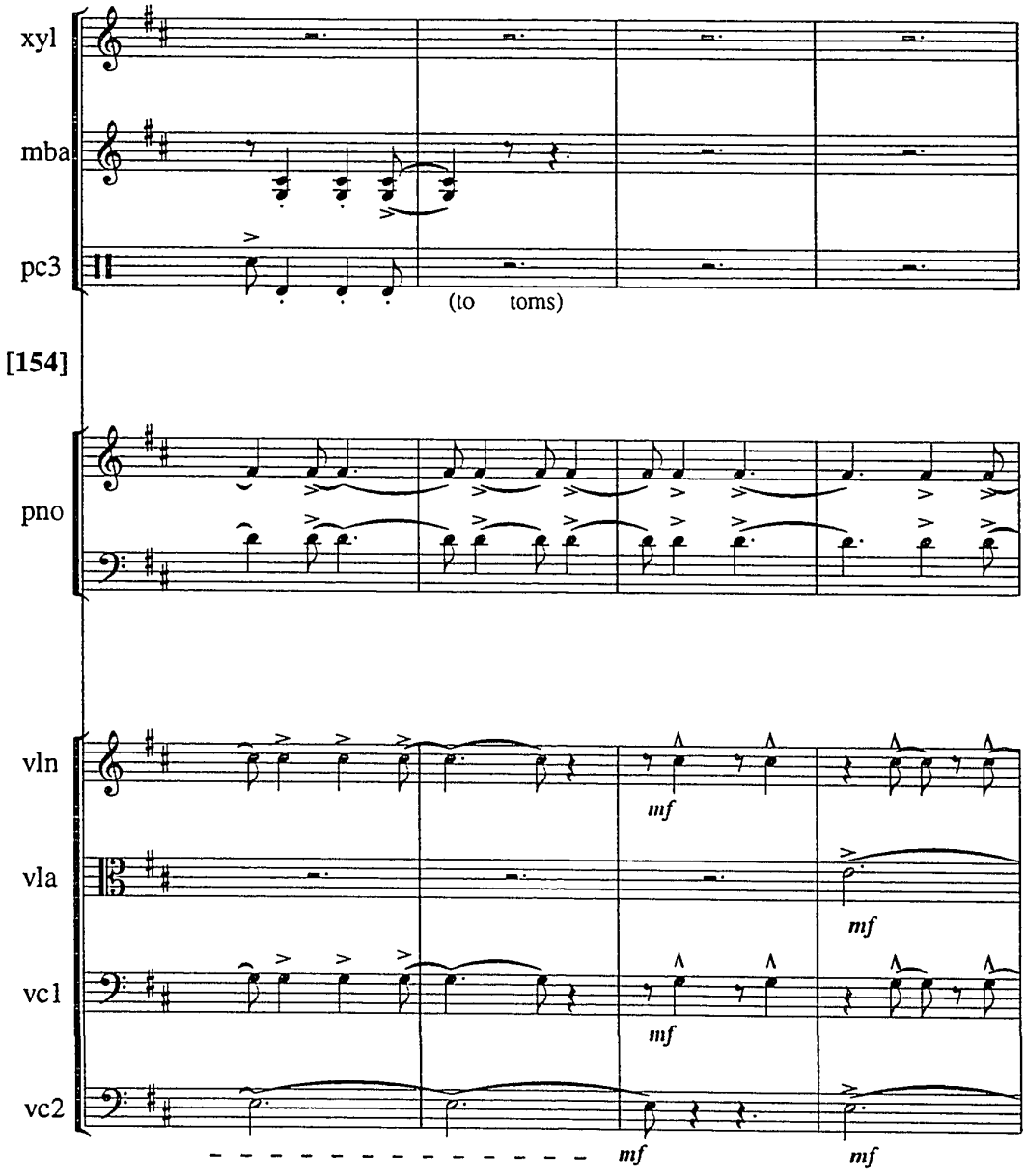

xyl
mba
pc3
ff
ff
mf
[134]
pno
ff
vln
vla
vc1
vc2
ff
ff
ff
ff
dim.
dim.
dim.
dim.

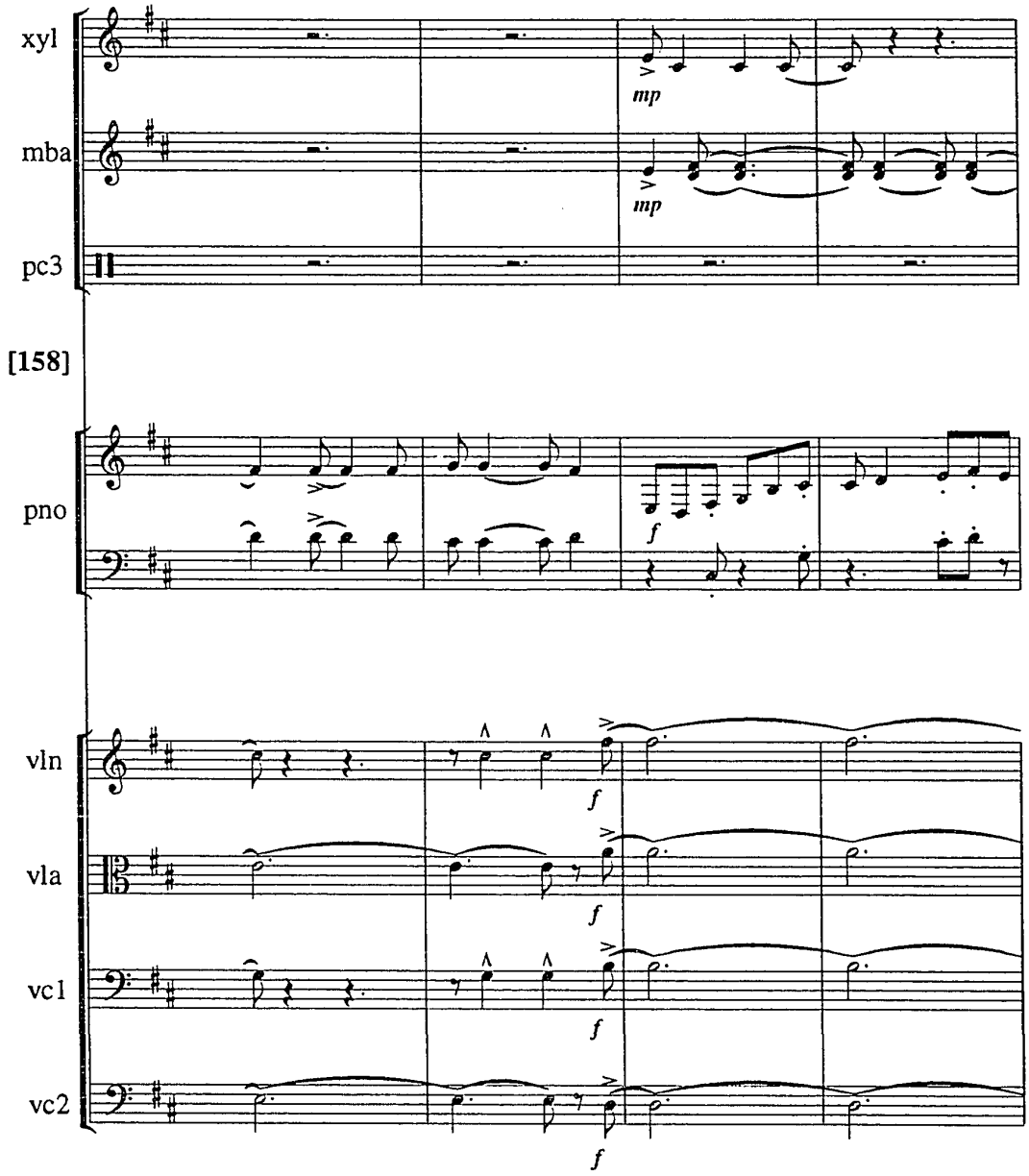

xyl
mba
pc3
mf
[138]
pno
f
mf
vln
mf
vla
mf
vc1
mf
vc2
f
dim.

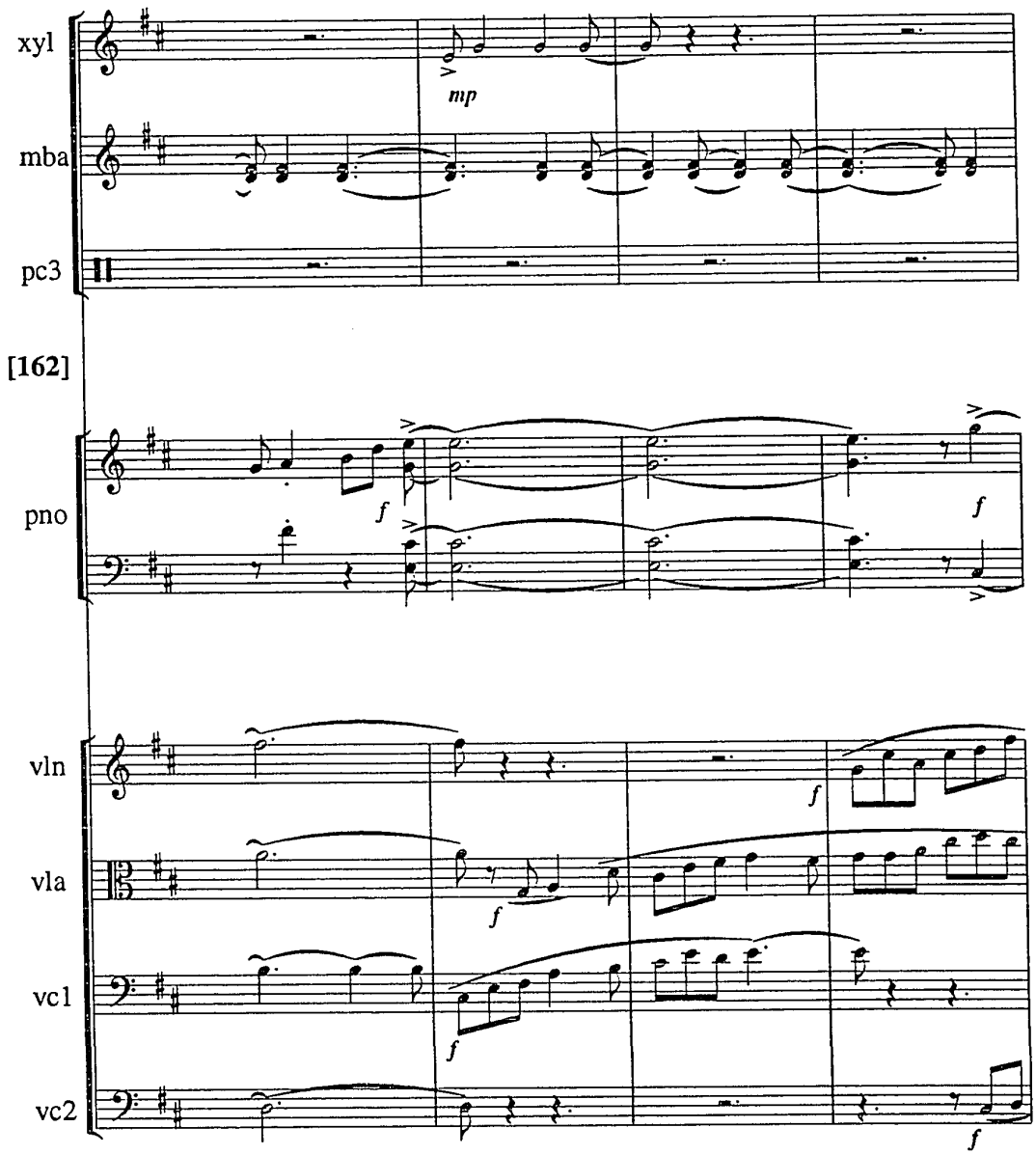

xyl
mba
pc3
mf
[142]
pno
mf
mf
vln
dim.
p
vla
mp
p
vc1
mp
p
vc2
mf
dim.
mp

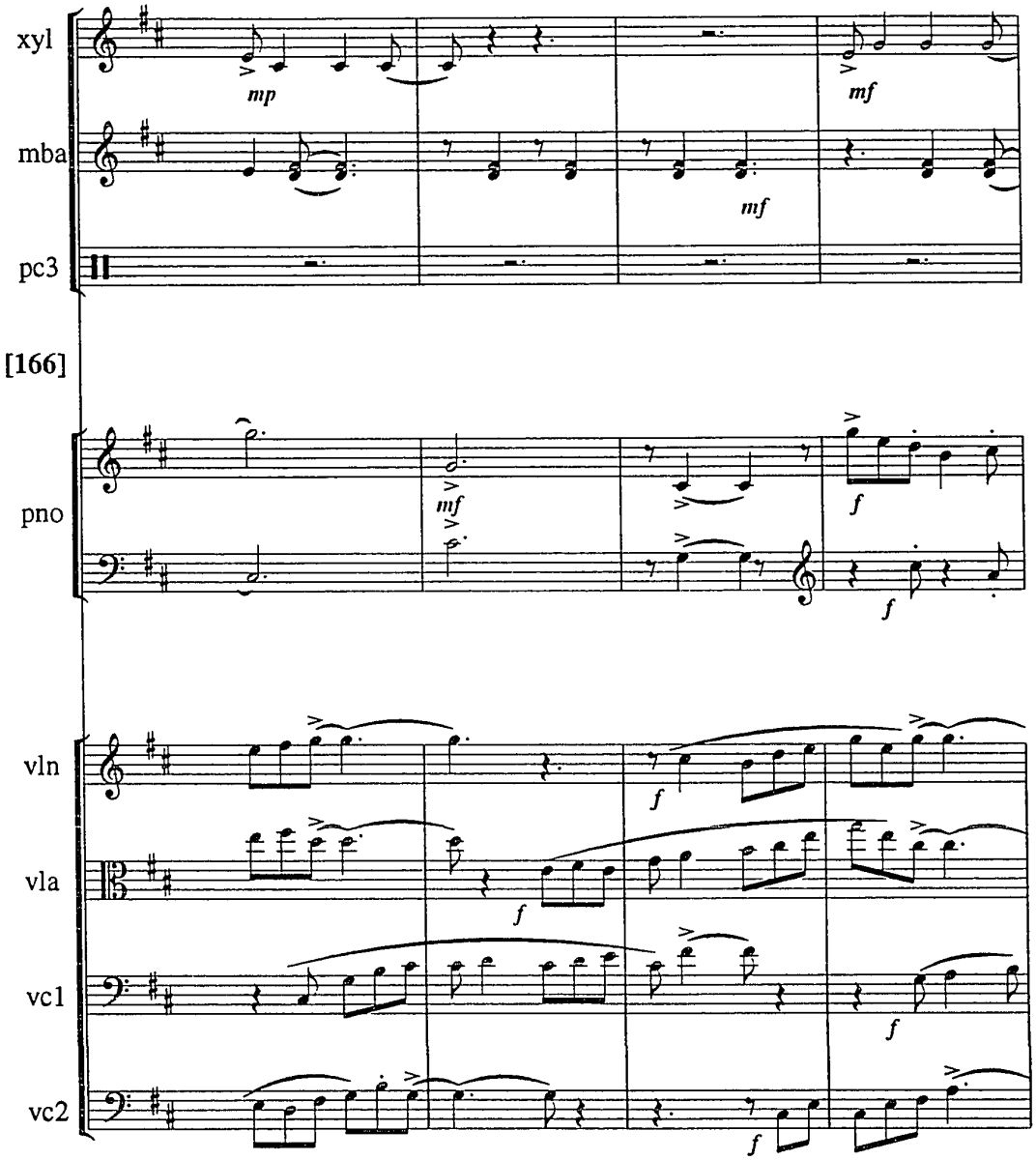

xyl
mba
pc3
mf
mp
[146]
pno
mf
vln
vla
vc1
vc2
mf
dim.

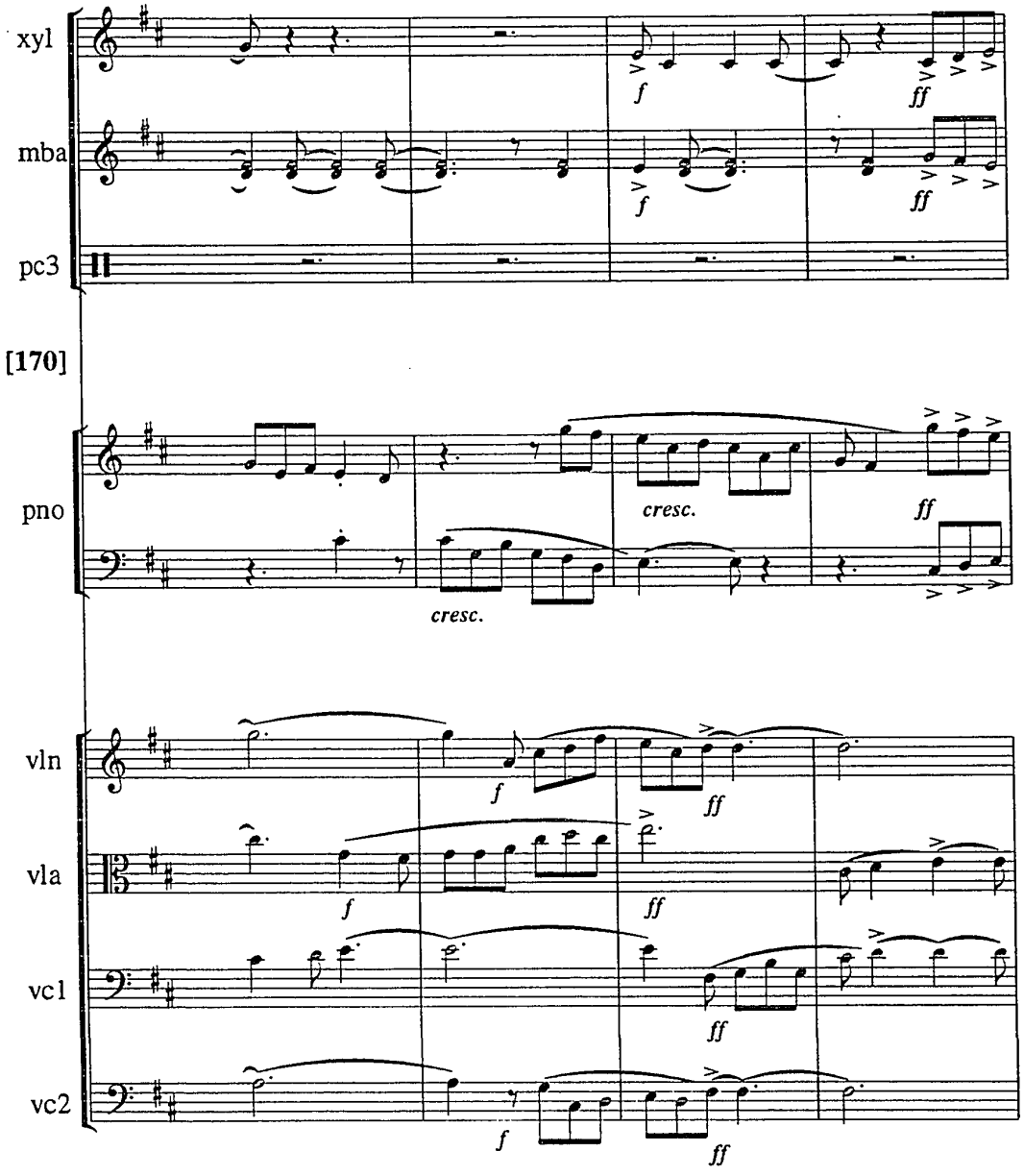

xyl
mba
pc3
mp
mp
mp
p
[150]
pno
mf
vln
vla
vc1
vc2
mf
mf
mp
cresc.

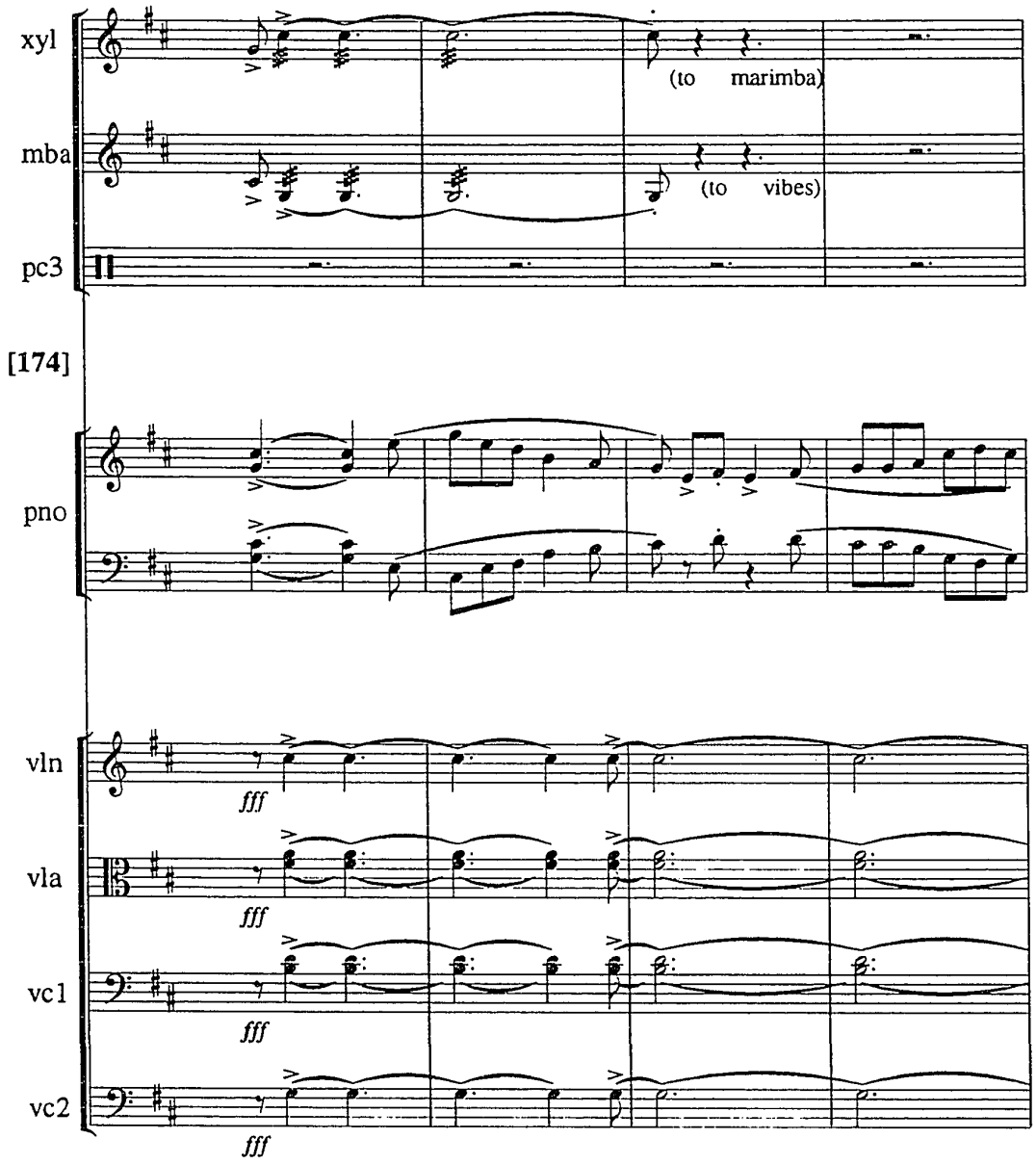

xyl
mba
pc3
(to toms)
[154]
pno
vln
mf
vla
mf
vc1
mf
vc2
mf
mf

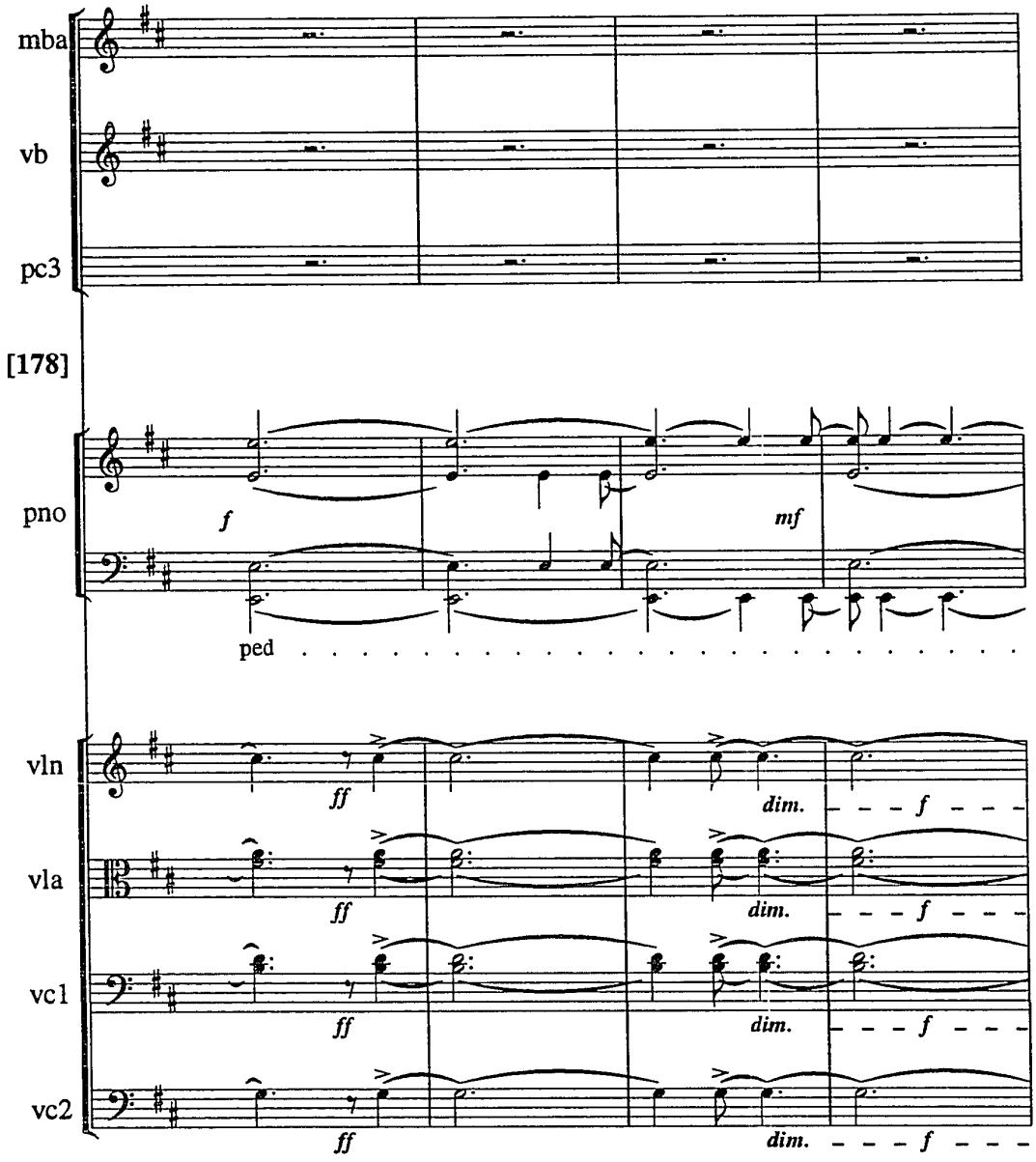

xyl
mba
pc3
mp
mp
[158]
pno
f
vln
vla
vc1
vc2
f
f
f
f

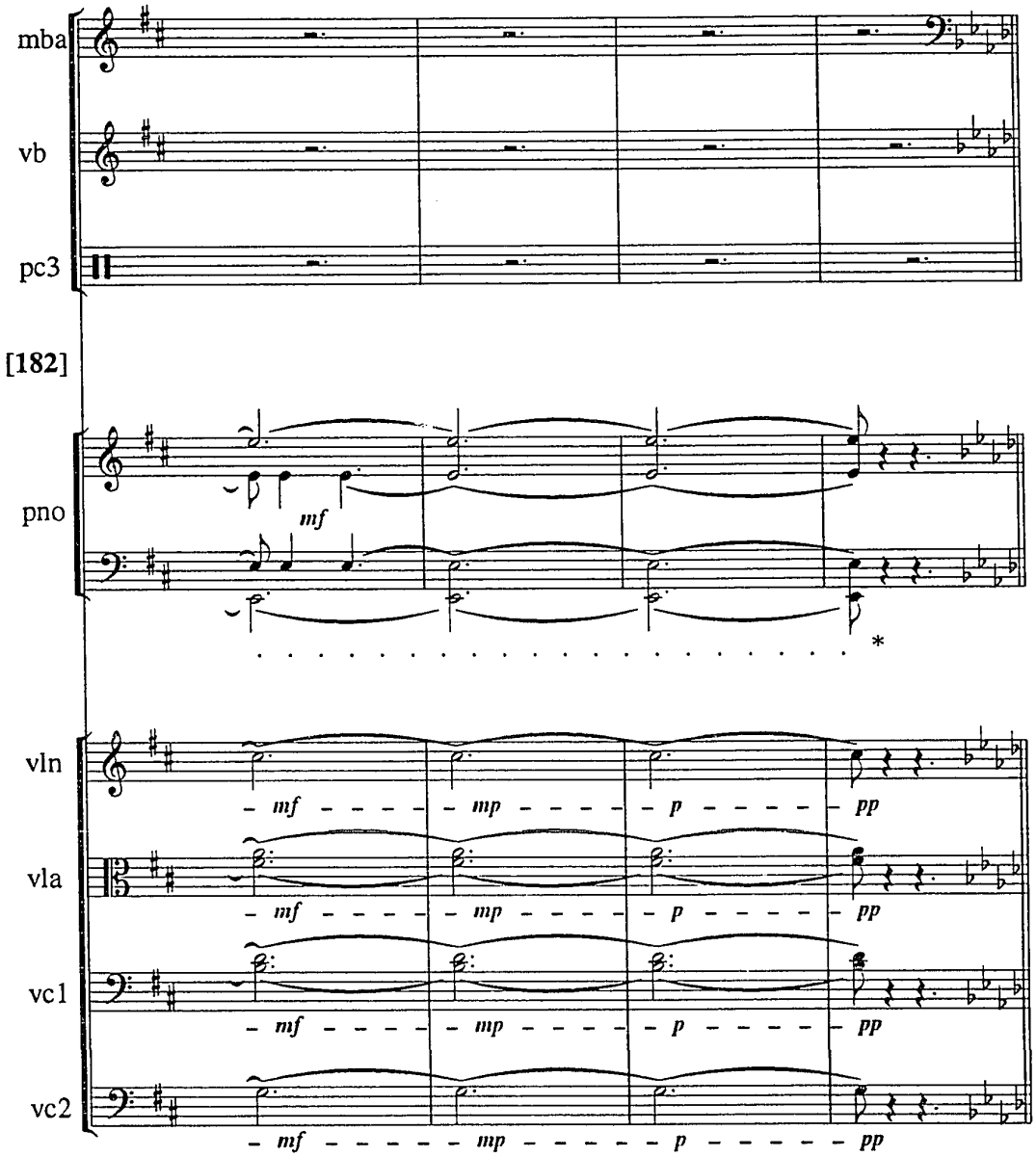

xyl
mba
pc3
mp
[162]
pno
f
f
vln
vla
vc1
vc2
f
f
f
f

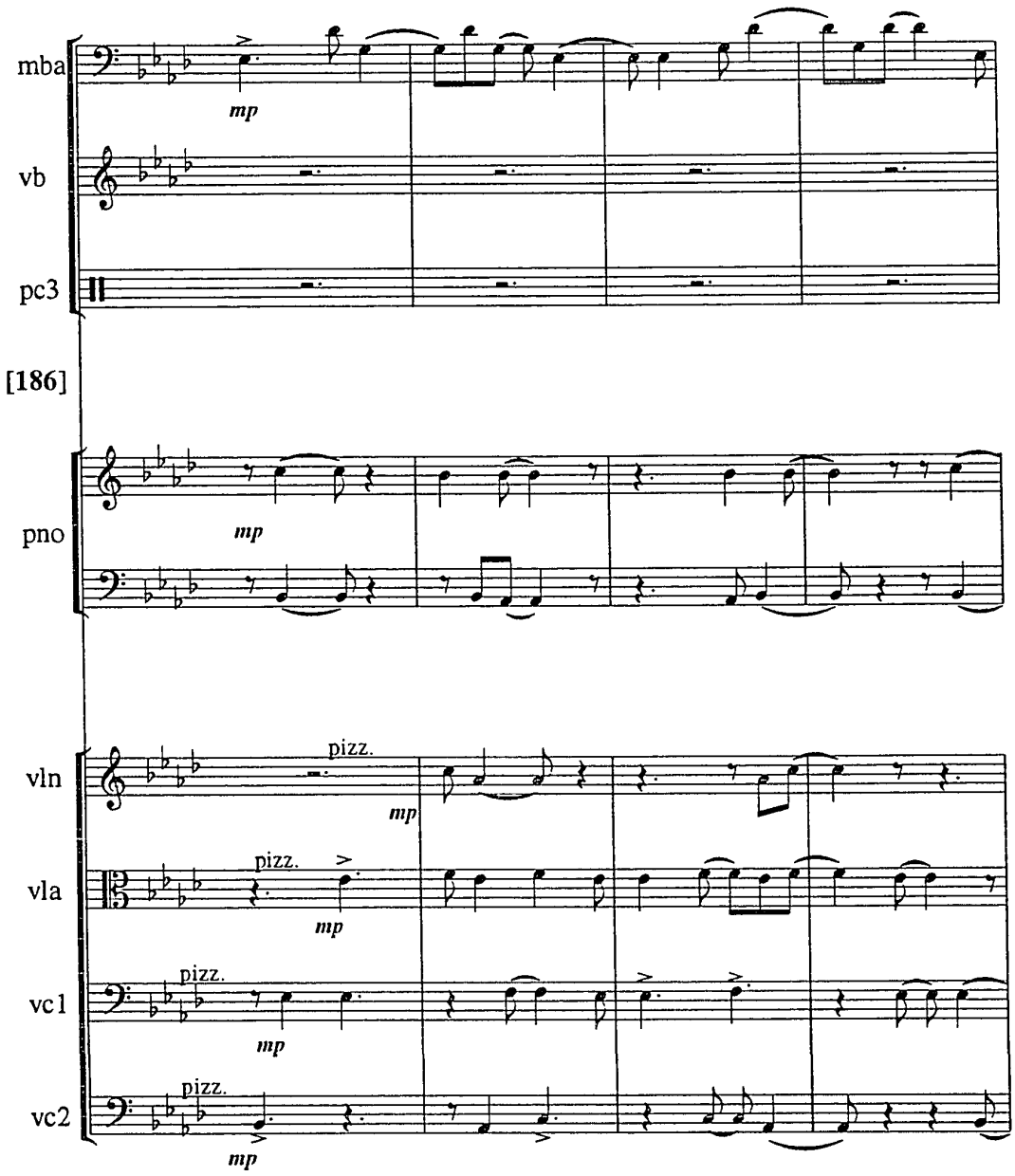

xyl
mba
pc3
[166]
pno
vln
vla
vc1
vc2
mp
mf
mf
mf
f
f
f
f
f
f

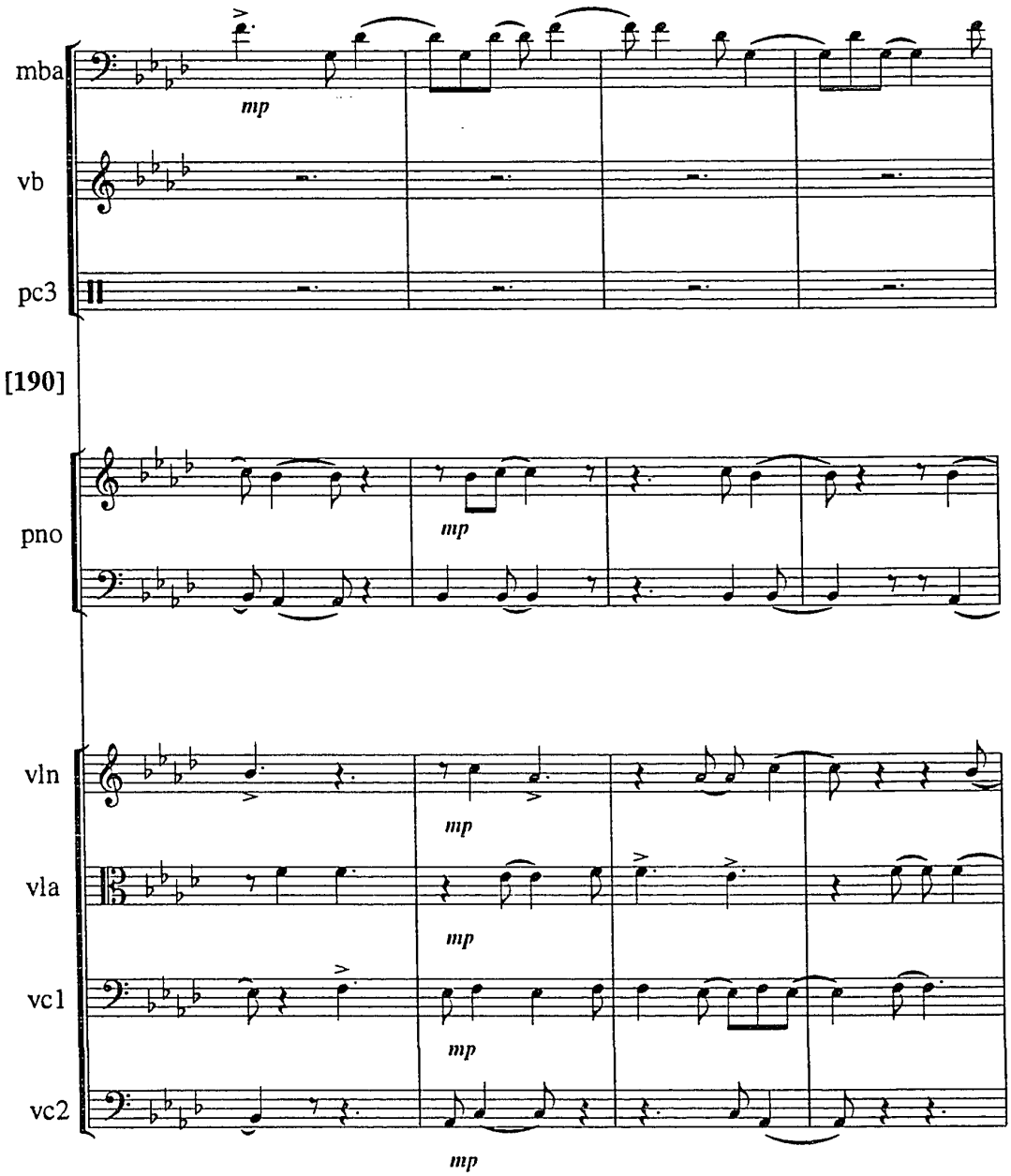

xyl
mba
pc3
[170]
pno
vln
vla
vc1
vc2
f
ff
cresc.

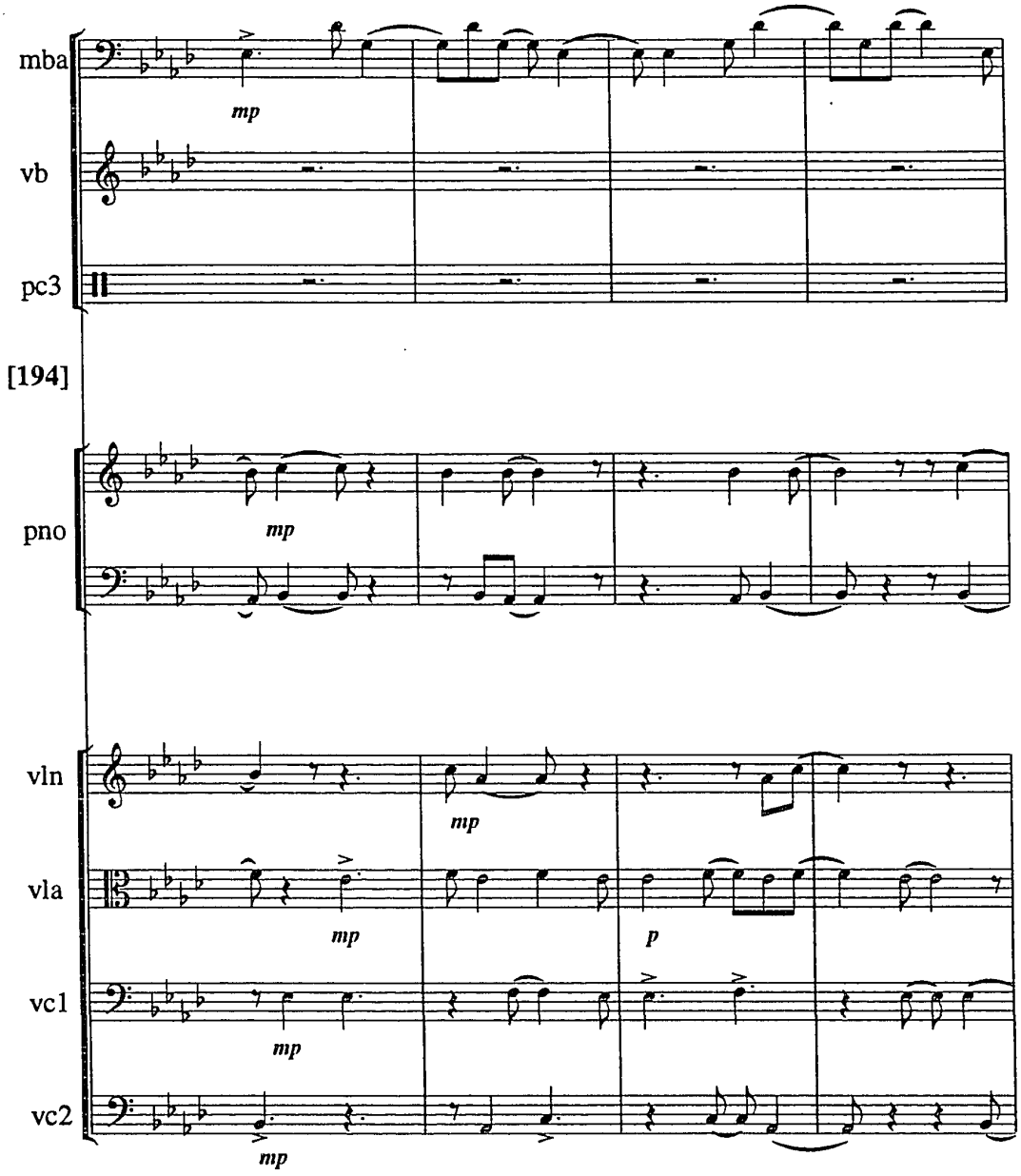

xyl
(to marimba)
mba
(to vibes)
pc3
[174]
pno
vln
fff
vla
fff
vc1
fff
vc2
fff

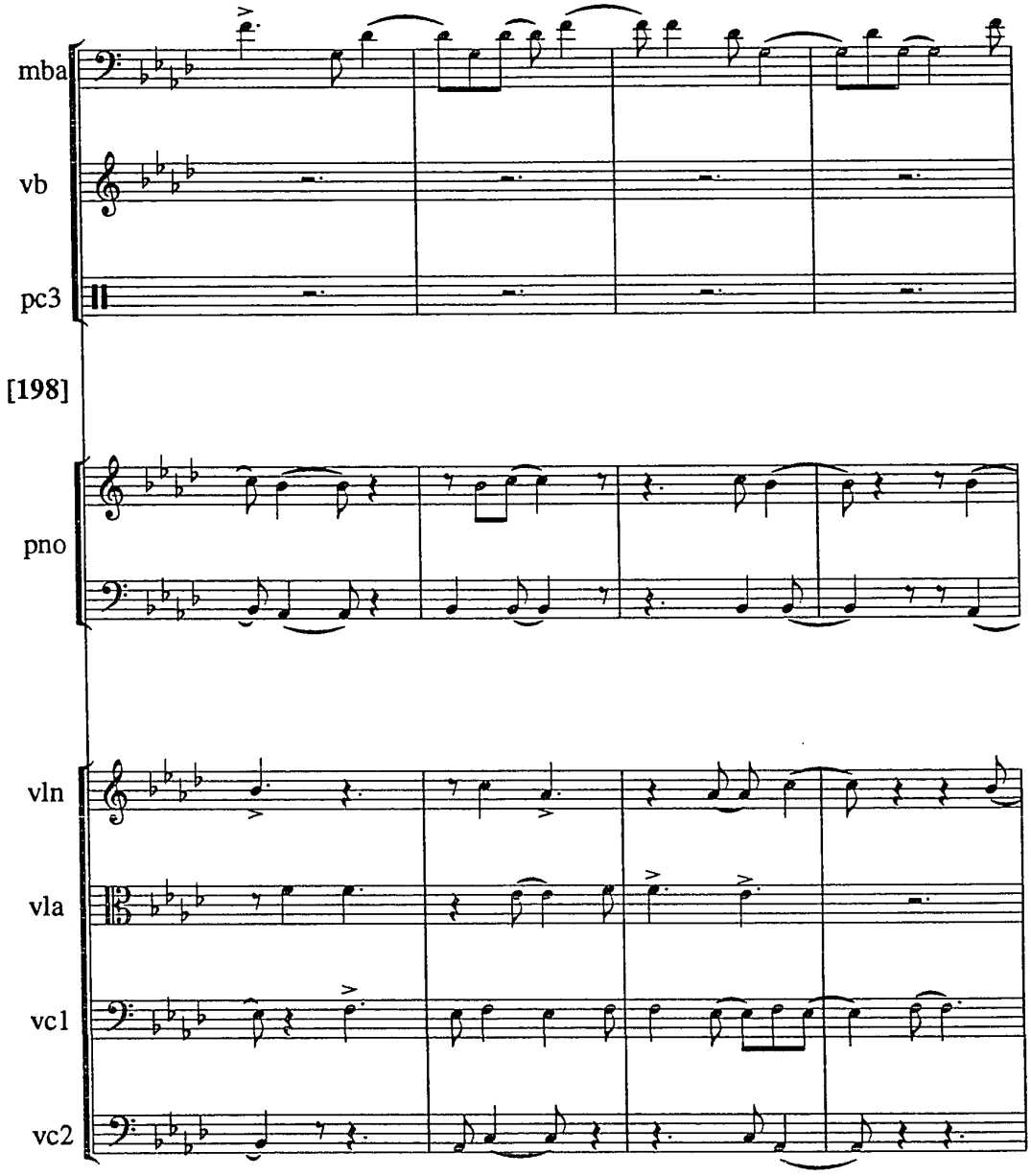

mba
vb
pc3
[178]
pno
f
mf
ped
vln
vla
vc1
vc2
ff
dim.
f

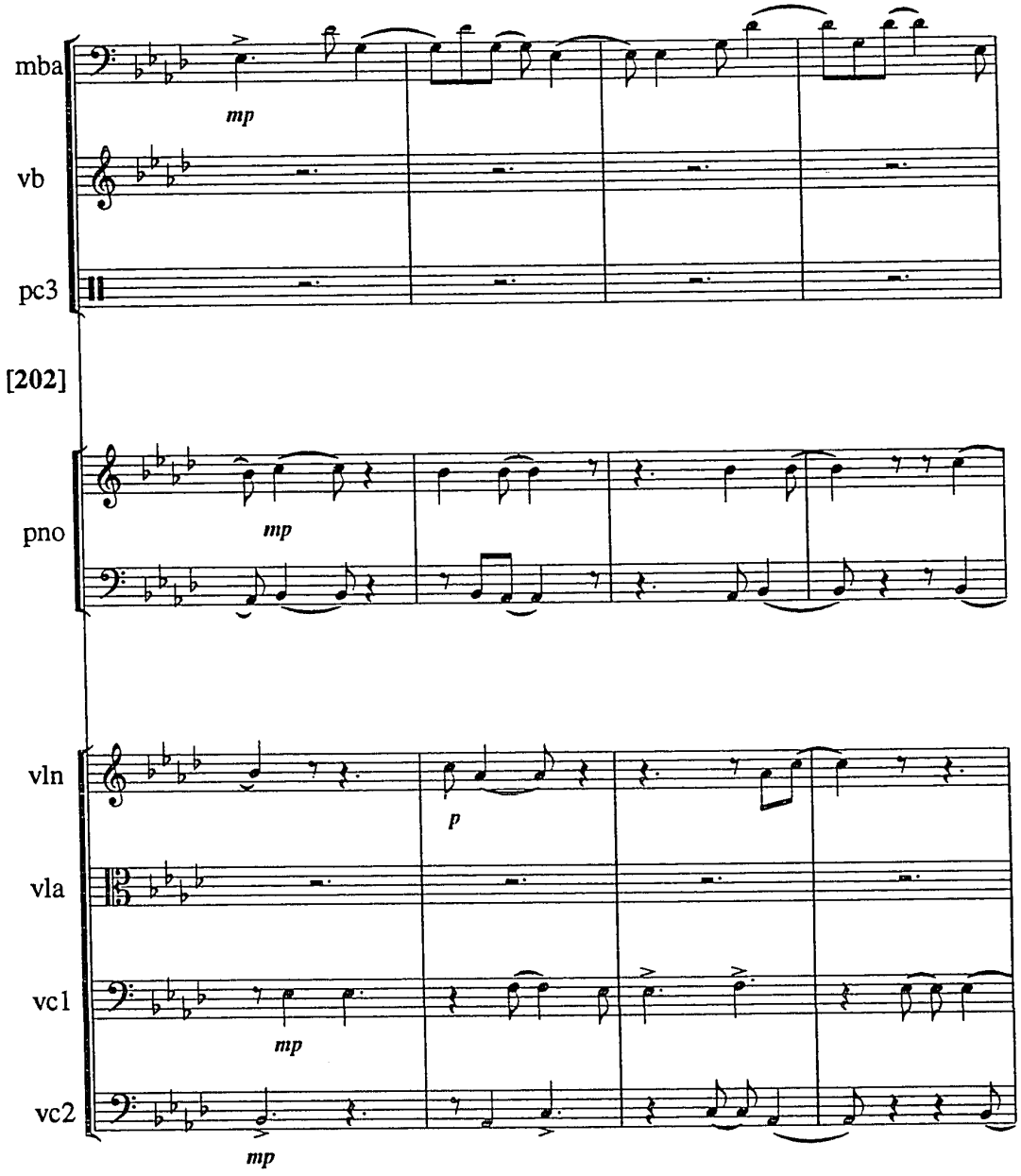

mba
vb
pc3
[182]
pno
mf
*
vln
mf
mp
p
pp
vla
mf
mp
p
pp
vc1
mf
mp
p
pp
vc2
mf
mp
p
pp

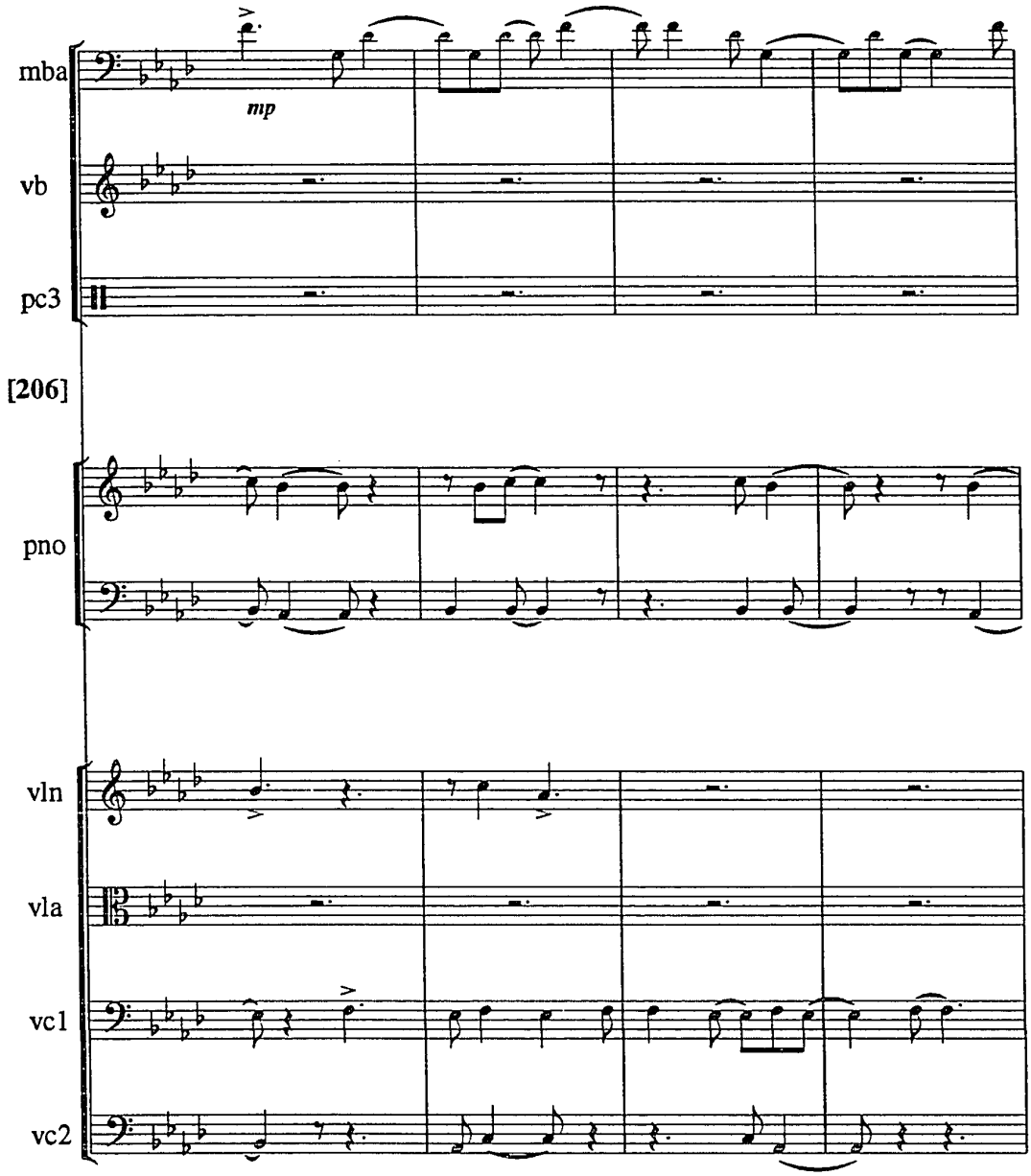

mba
vb
pc3
[186]
pno
vln
vla
vc1
vc2
mp
pizz.

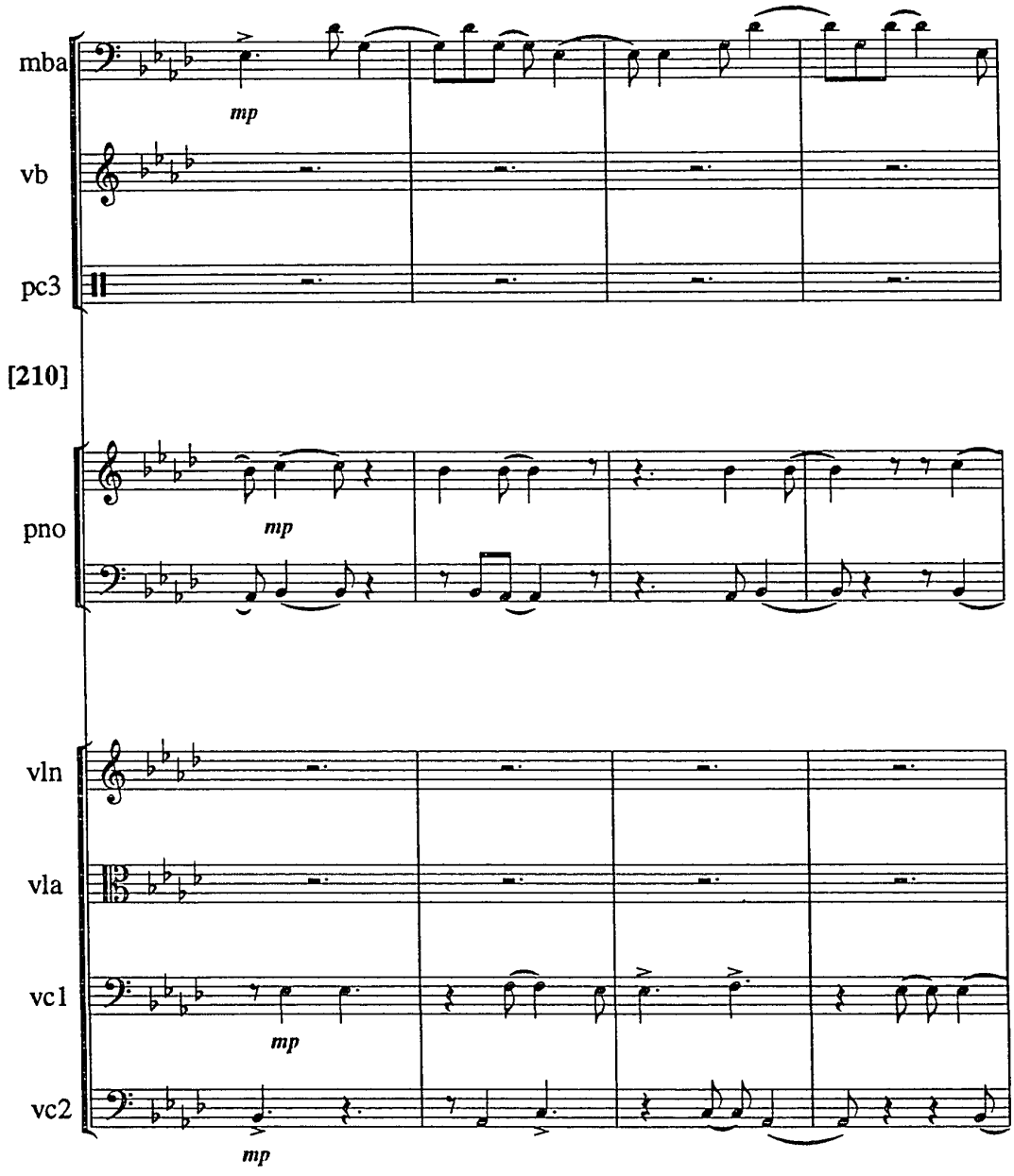

mba
vb
pc3
[190]
pno
vln
vla
vc1
vc2
mp

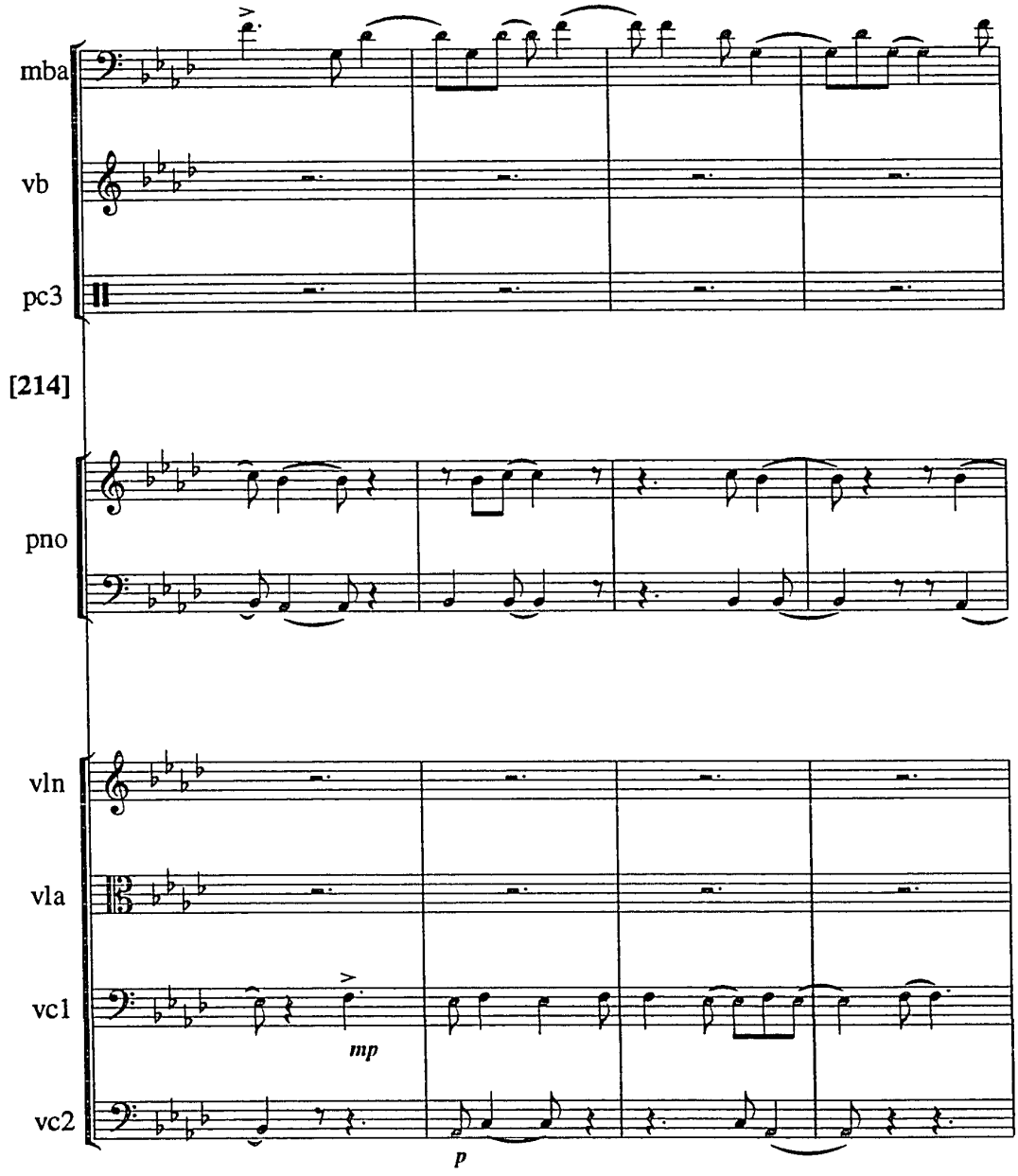

mba
vb
pc3
[194]
pno
vln
vla
vc1
vc2
mp
mp
mp
mp
p
mp

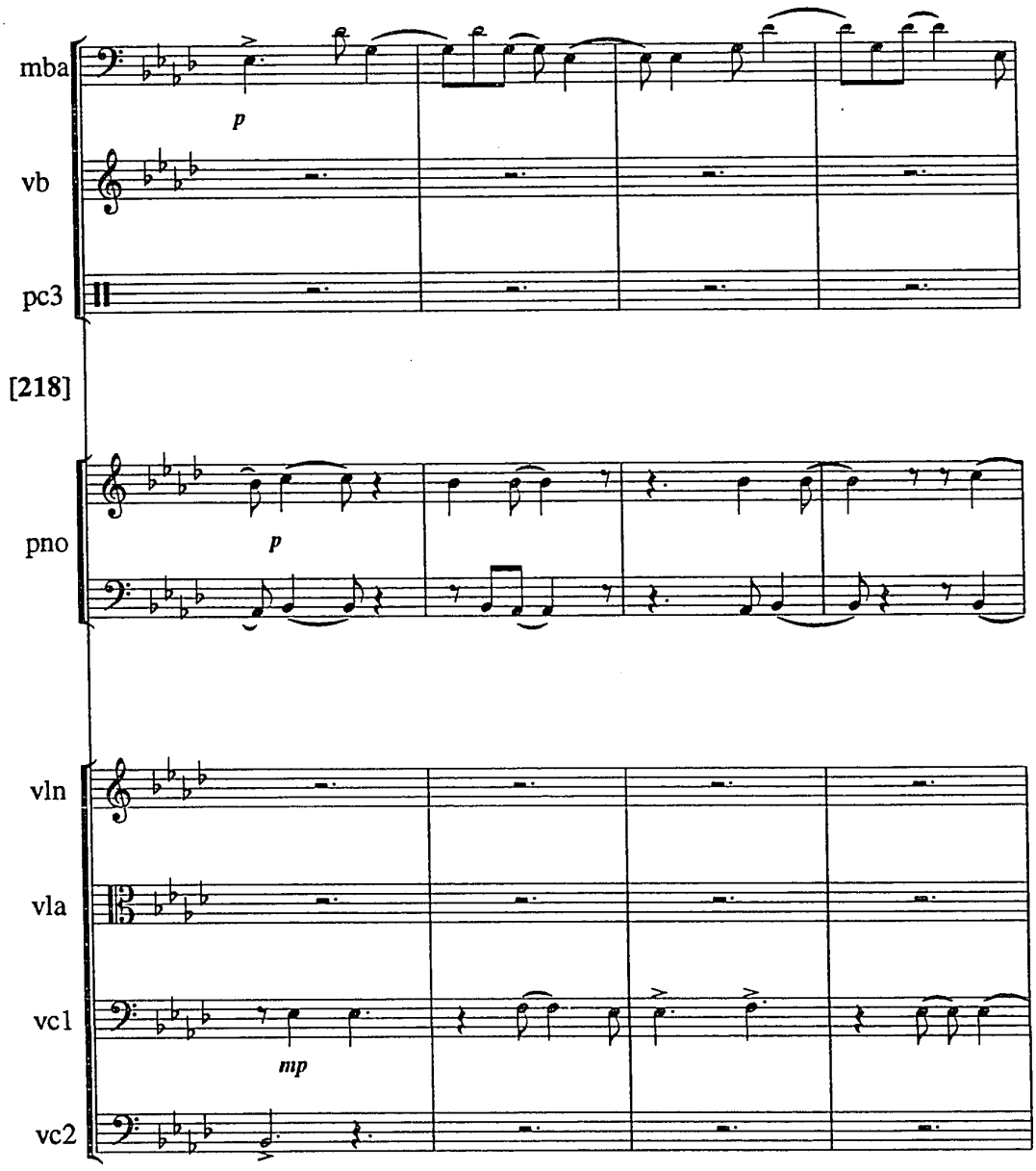

mba
vb
pc3
[198]
pno
vln
vla
vc1
vc2

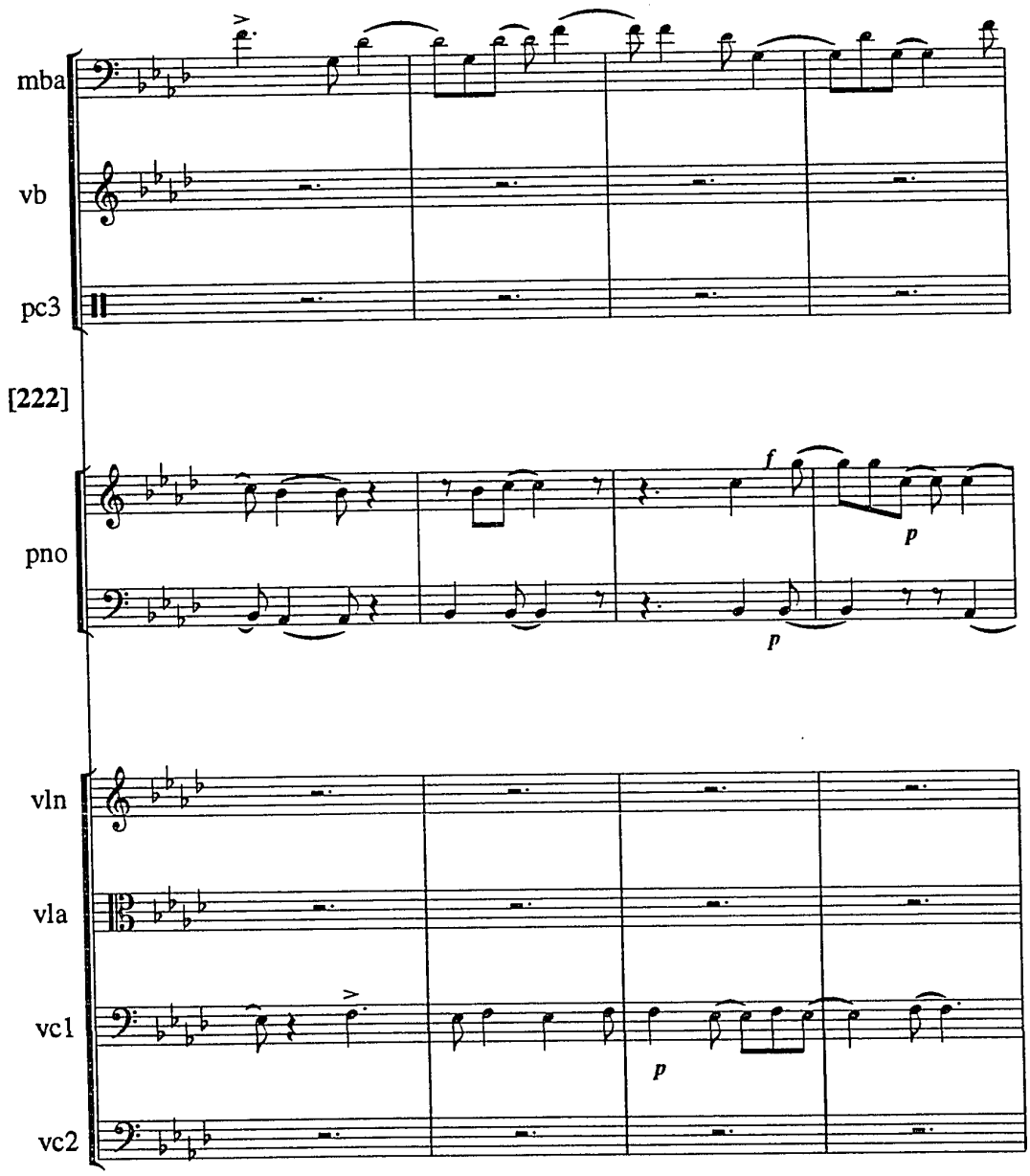

mba
mp
vb
pc3
[202]
pno
mp
vln
p
vla
vc1
mp
vc2
mp

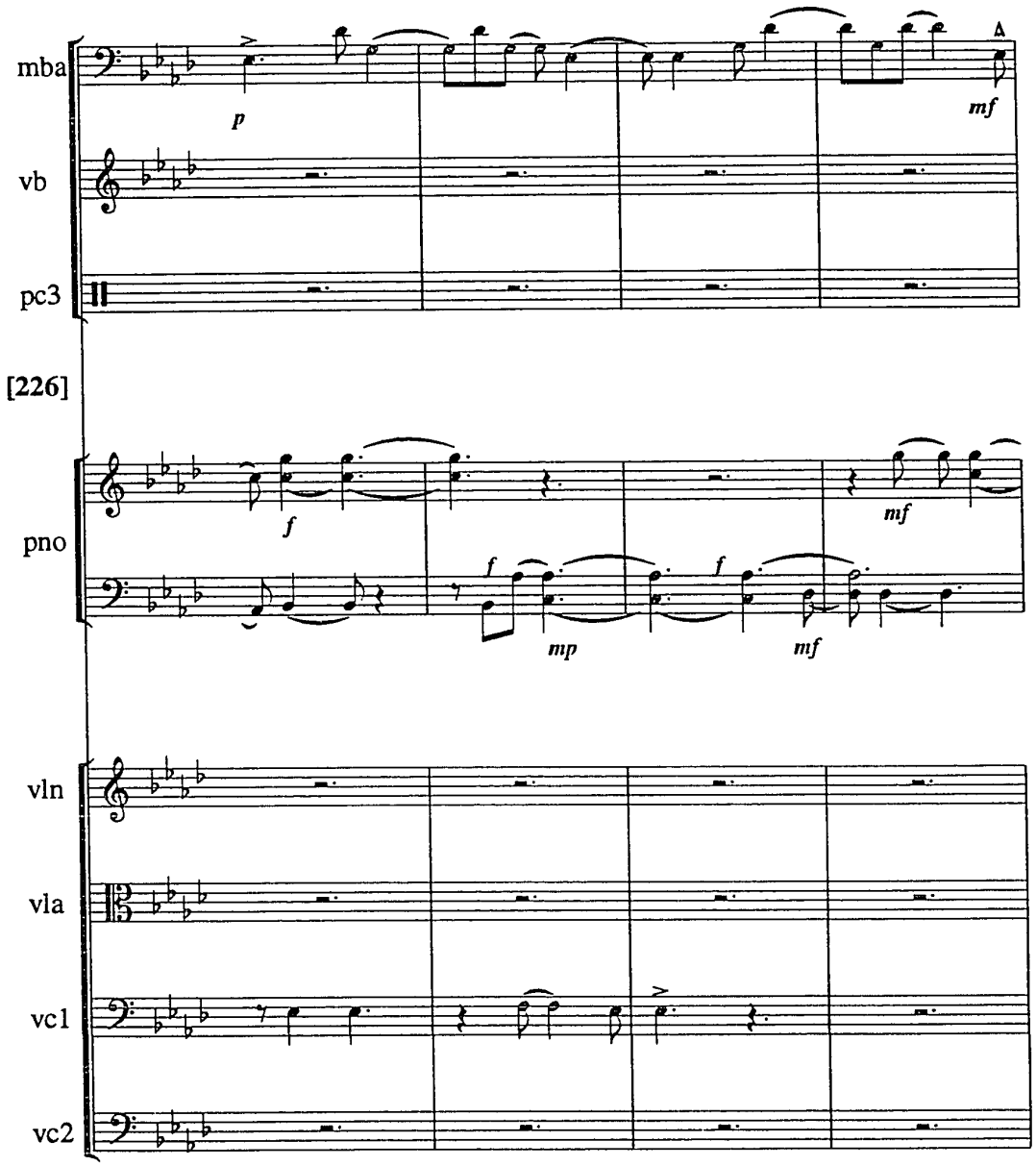

mba
mp
vb
pc3
[206]
pno
vln
vla
vc1
vc2

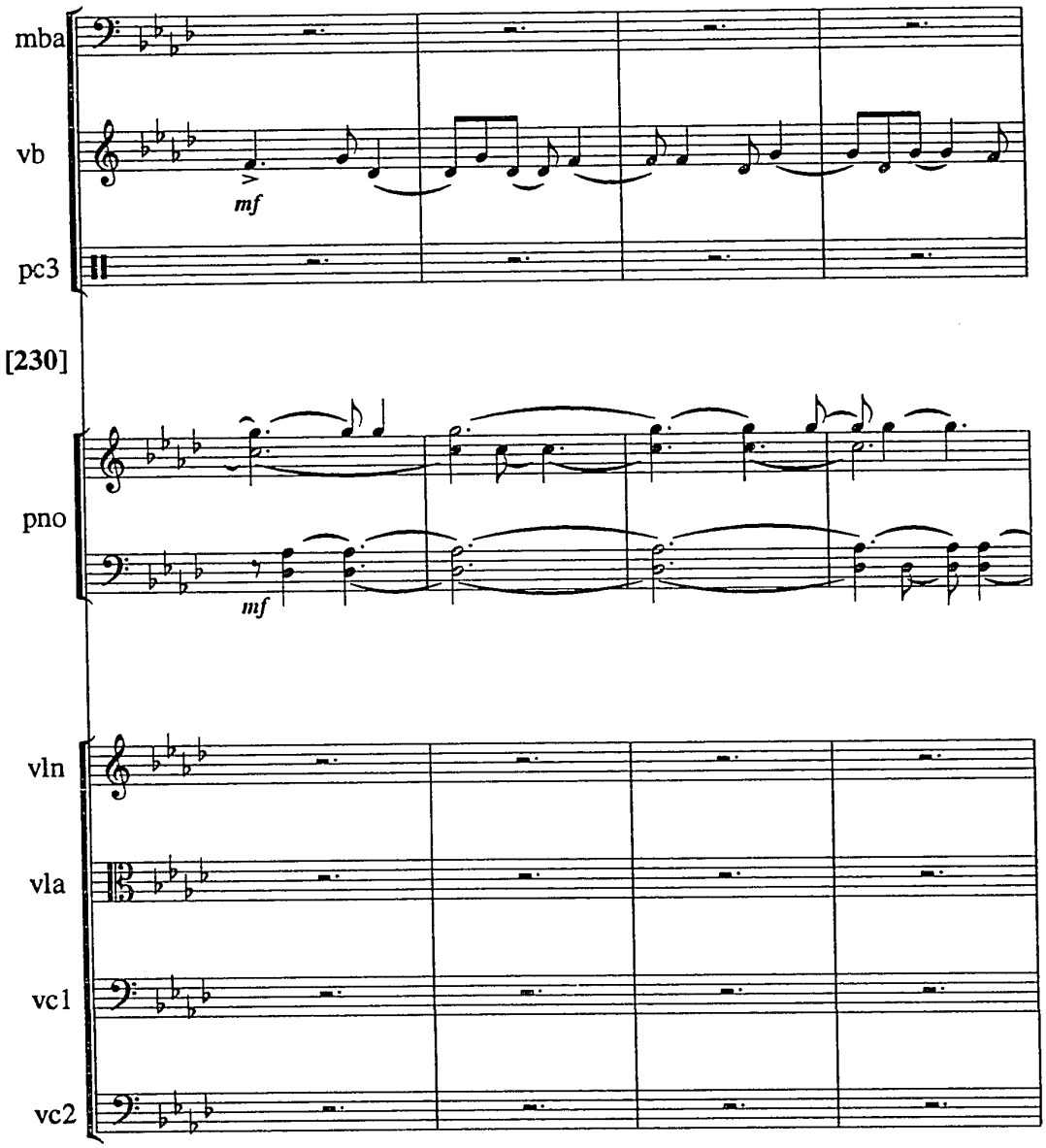

mba
mp
vb
pc3
[210]
pno
mp
vln
vla
vc1
mp
vc2
mp

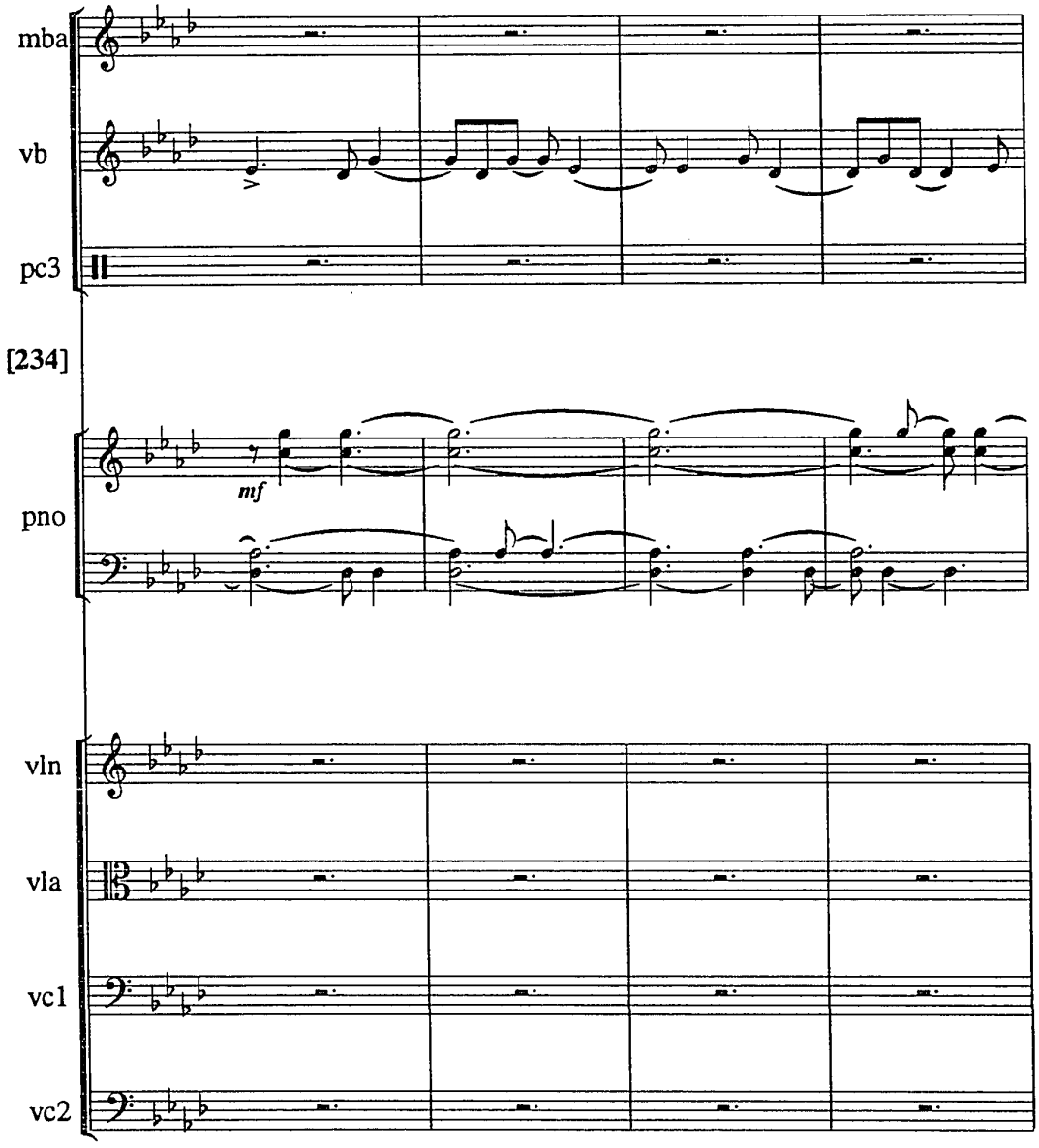

mba
vb
pc3
[214]
pno
vln
vla
vc1
mp
vc2
p

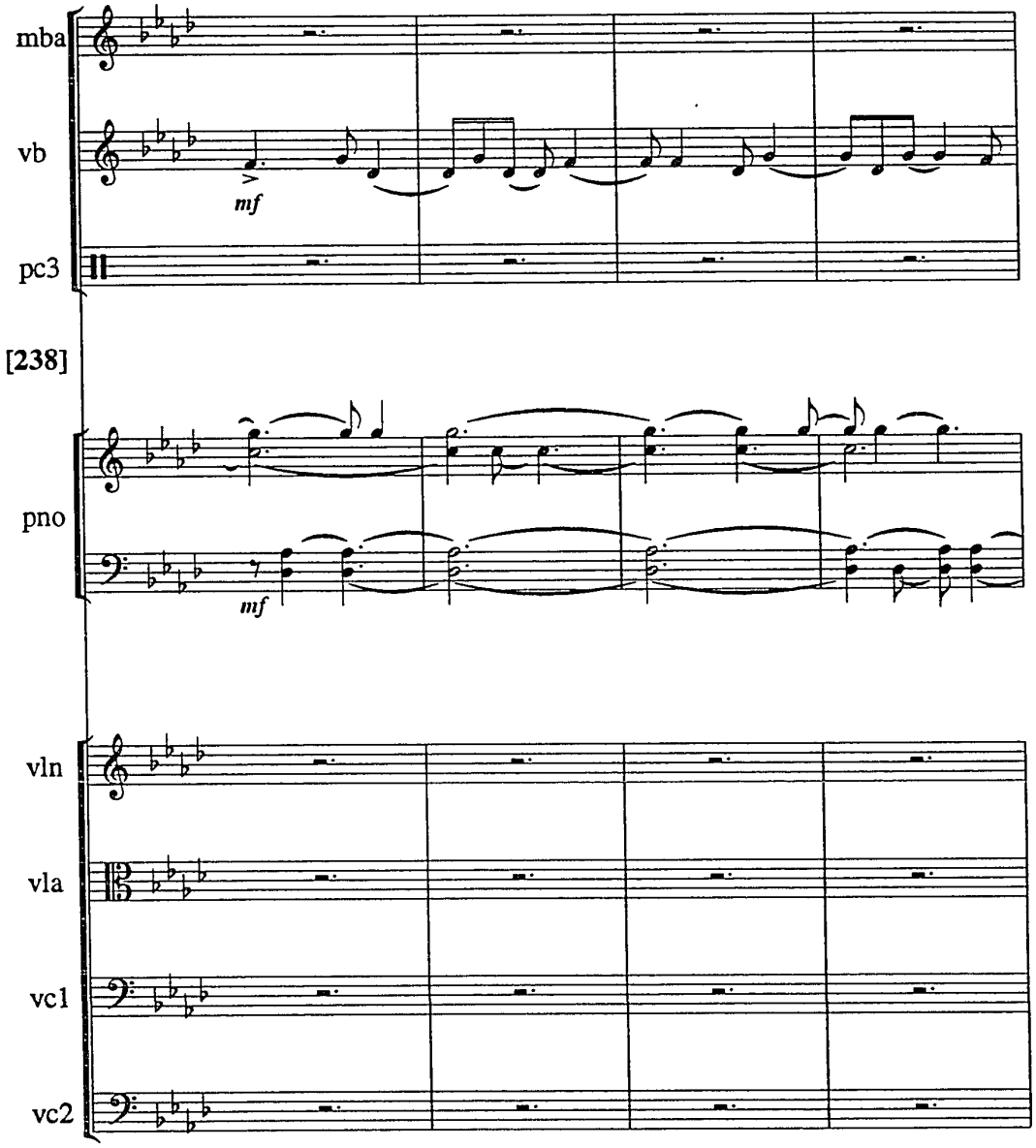

mba
p
vb
pc3
[218]
pno
p
vln
vla
vc1
mp
vc2

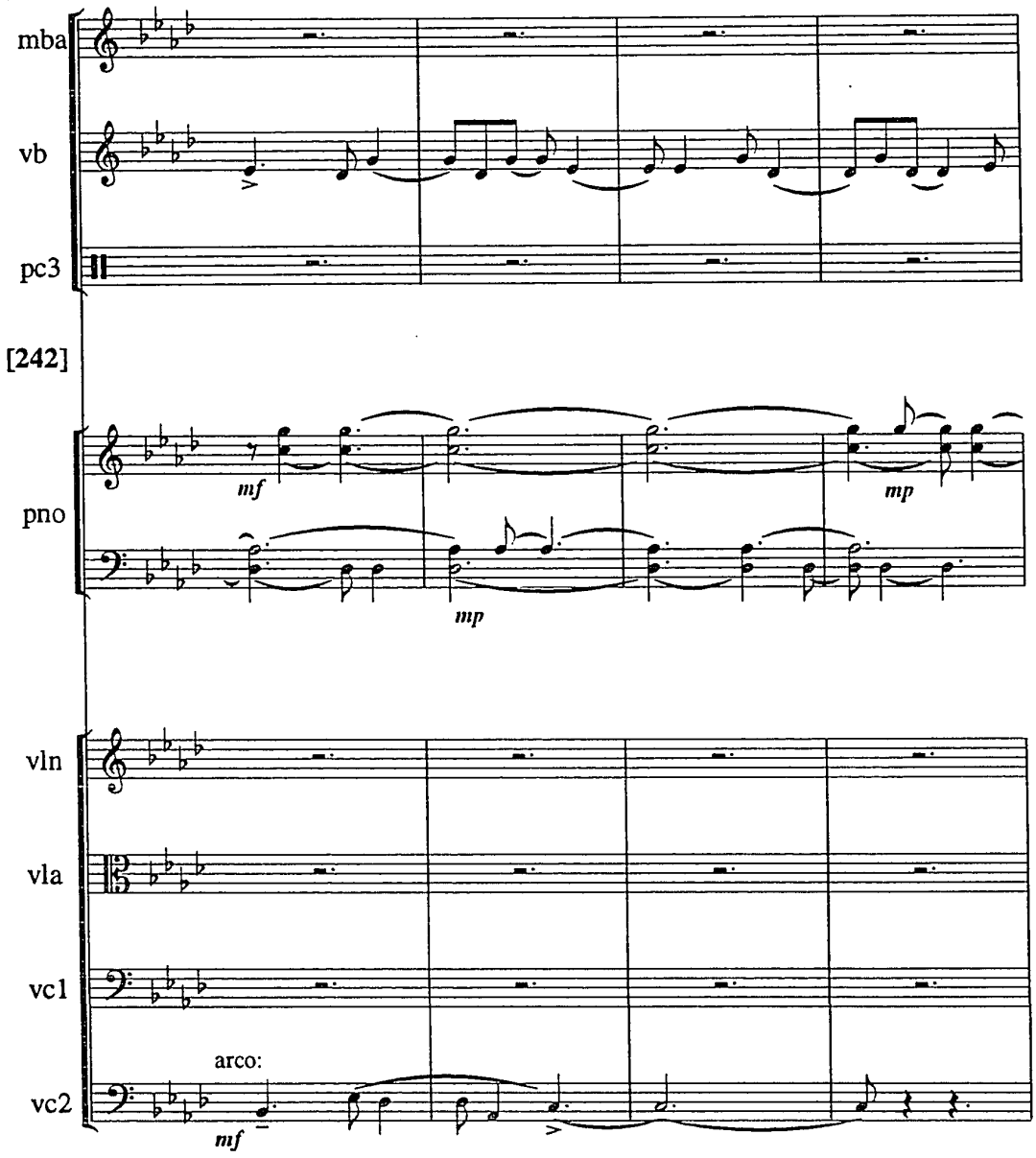

mba
vb
pc3
[222]
pno
f
p
p
vln
vla
vc1
p
vc2

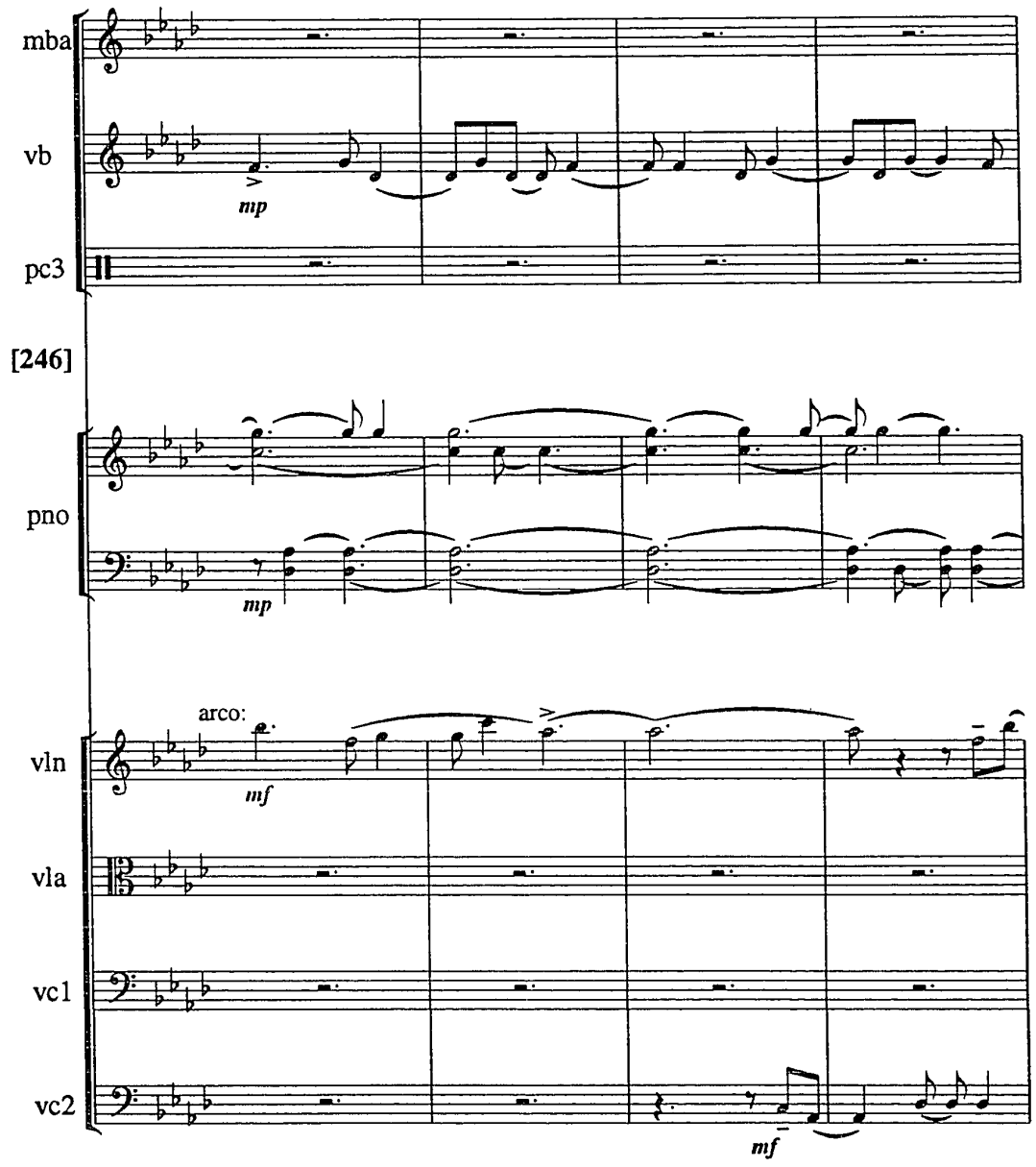

mba
vb
pc3
[226]
pno
vln
vla
vc1
vc2
A
p
mf
f
mf
f
mp
f
mf

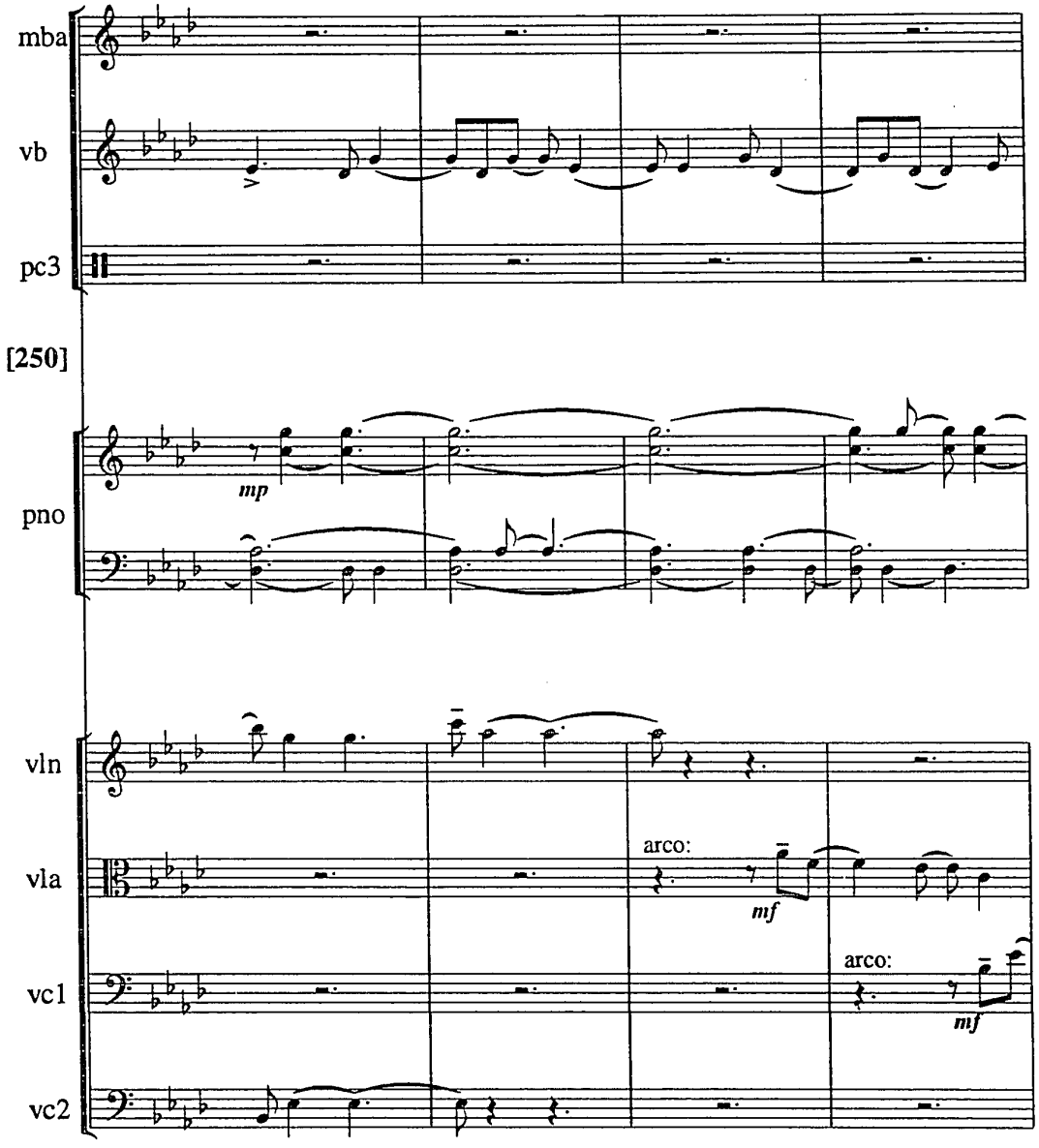

mba
vb
mf
pc3
[230]
pno
mf
vln
vla
vc1
vc2

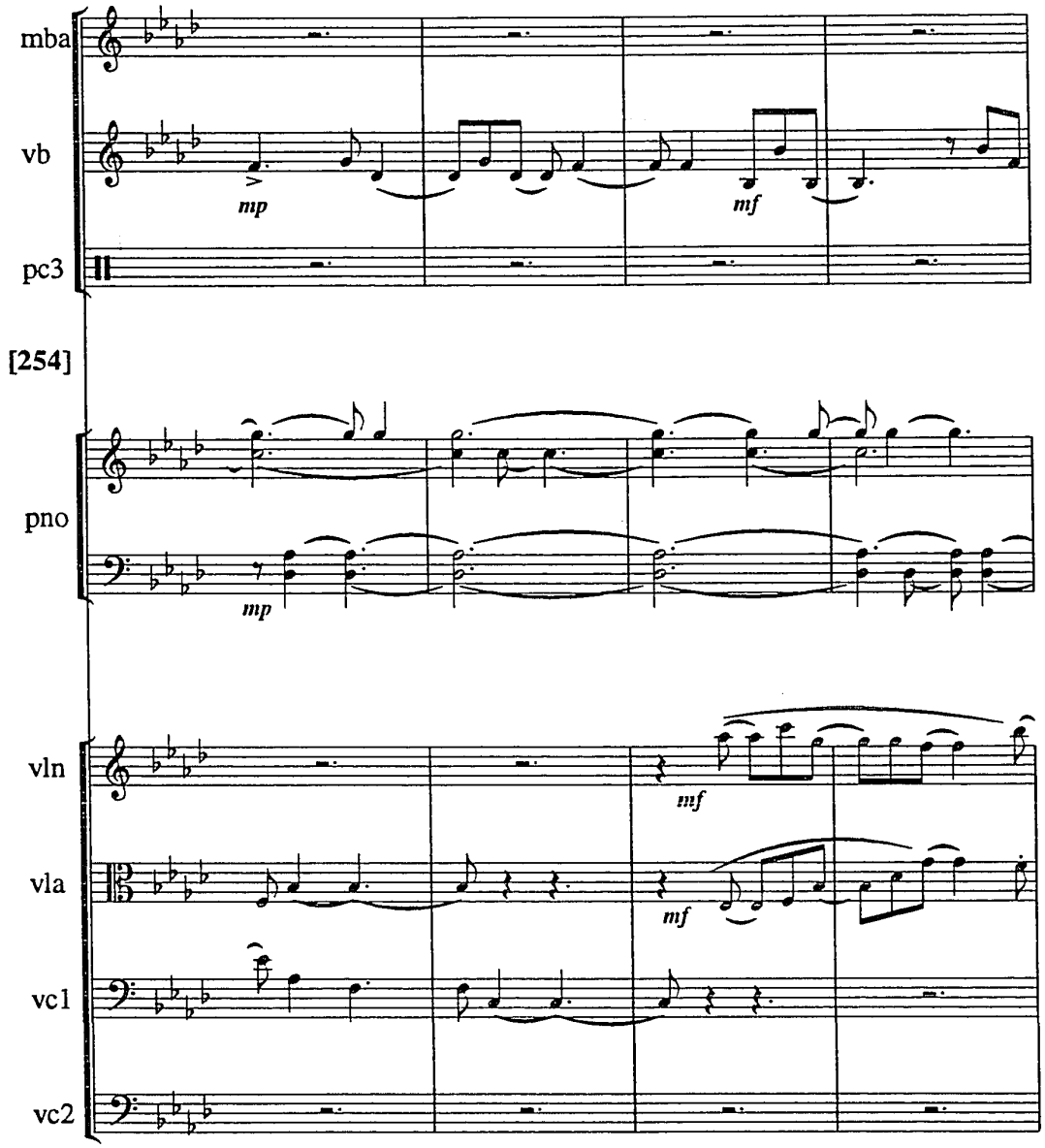

mba
vb
pc3
[234]
mf
pno
vln
vla
vc1
vc2

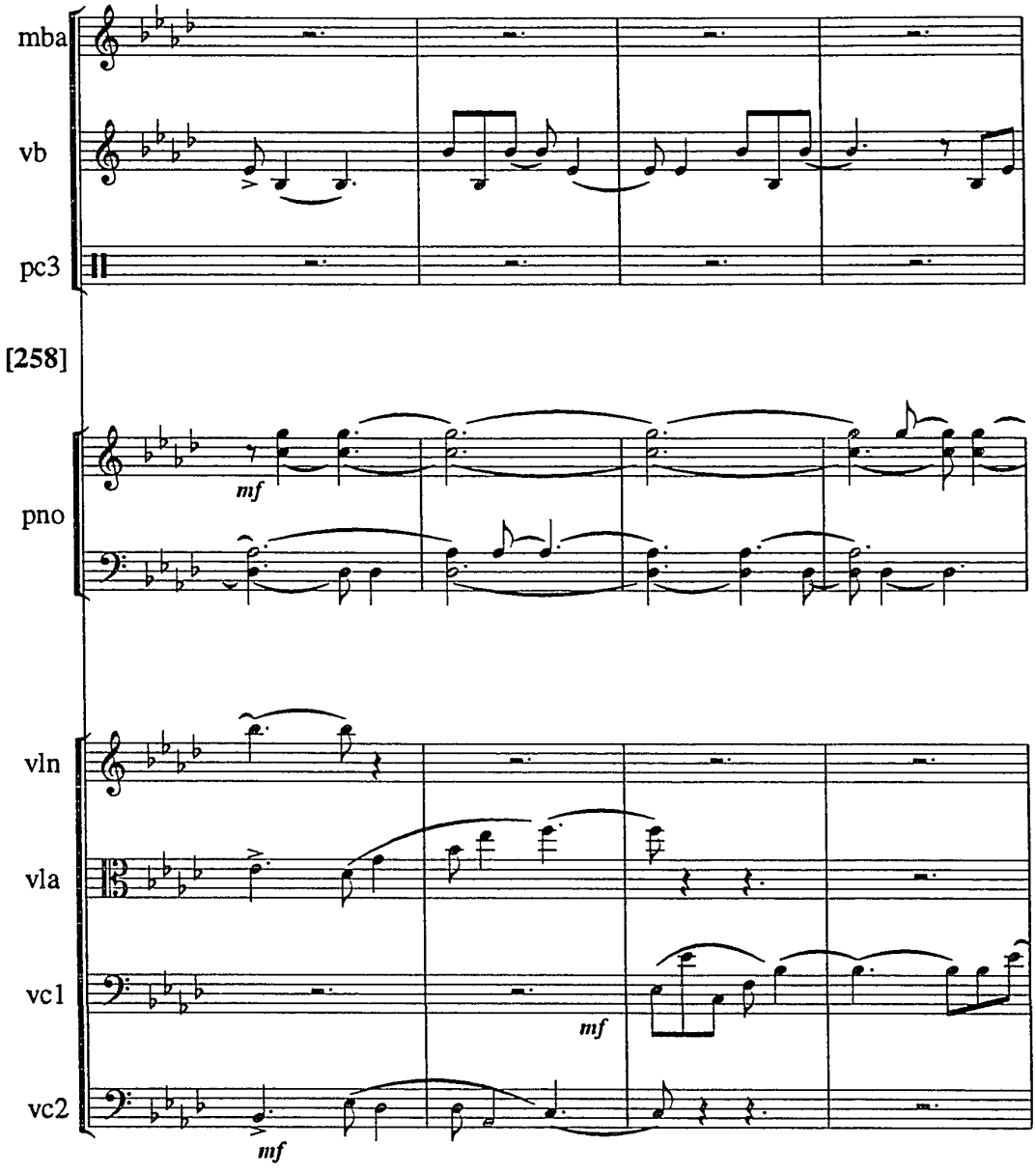

mba
vb
mf
pc3
[238]
pno
mf
vln
vla
vc1
vc2

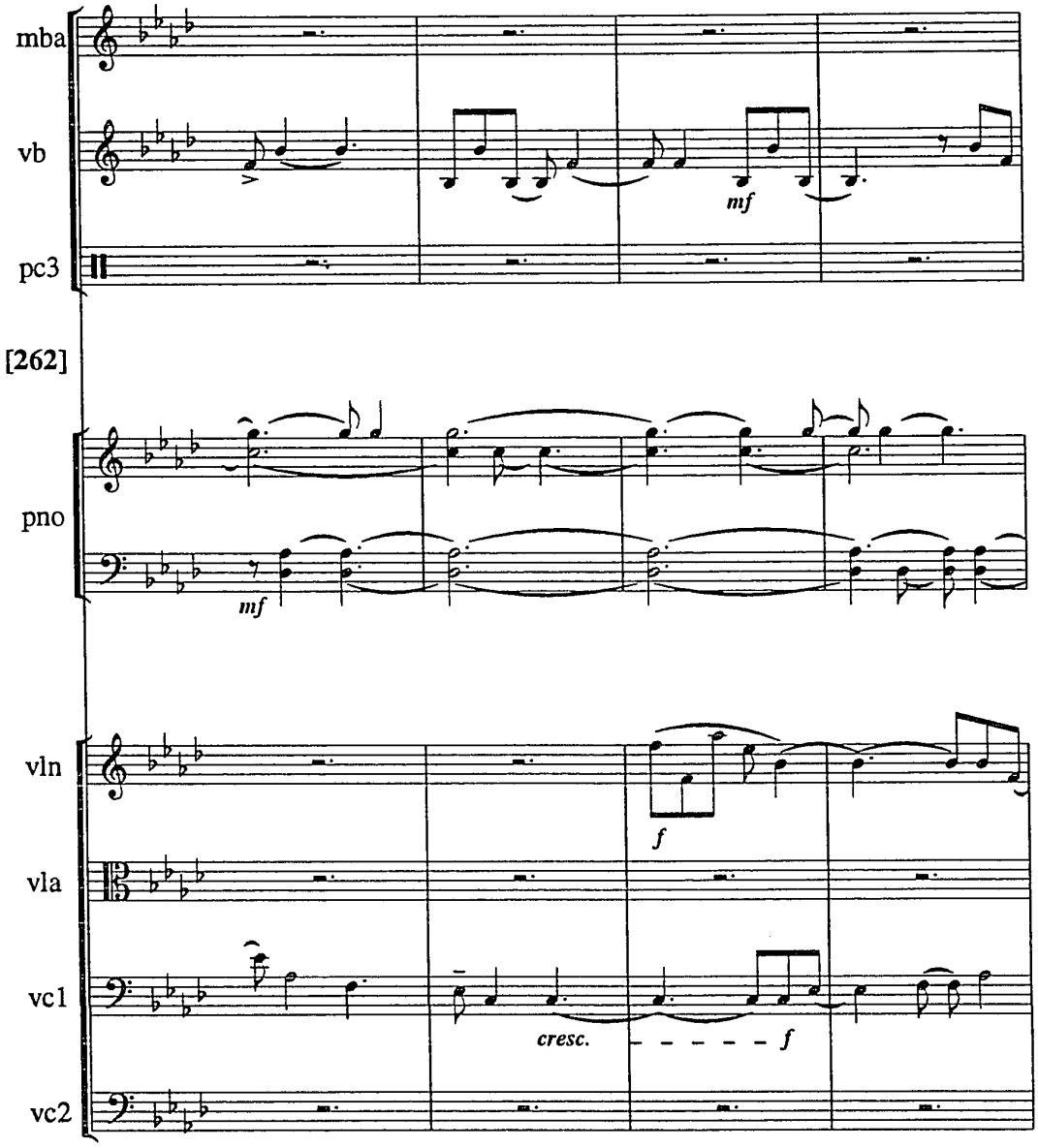

mba
vb
pc3
[242]
pno
mf
mp
mp
vln
vla
vc1
arco:
vc2
mf

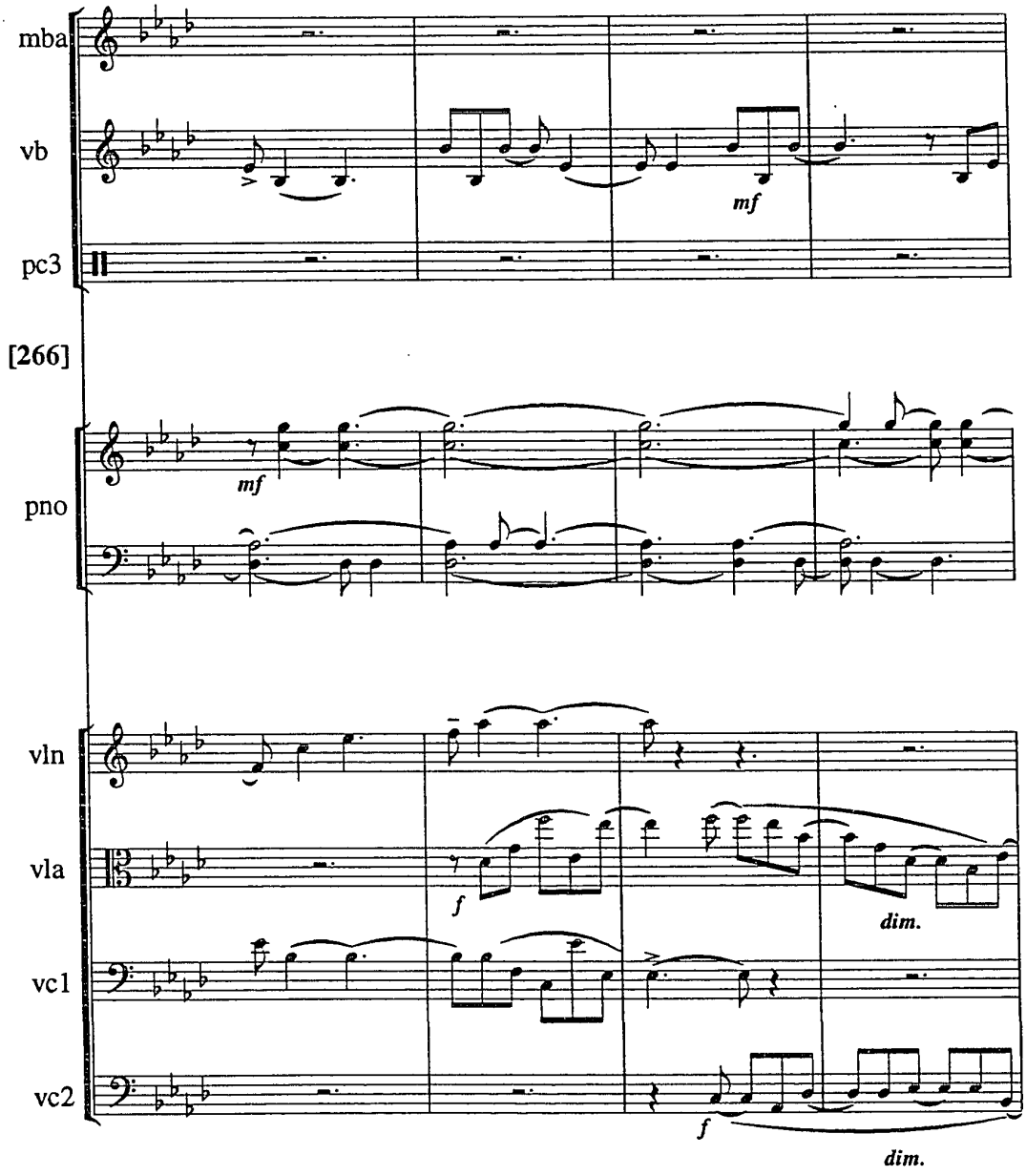

mba
vb
mp
pc3
[246]
pno
mp
arco:
vln
mf
vla
vc1
vc2
mf

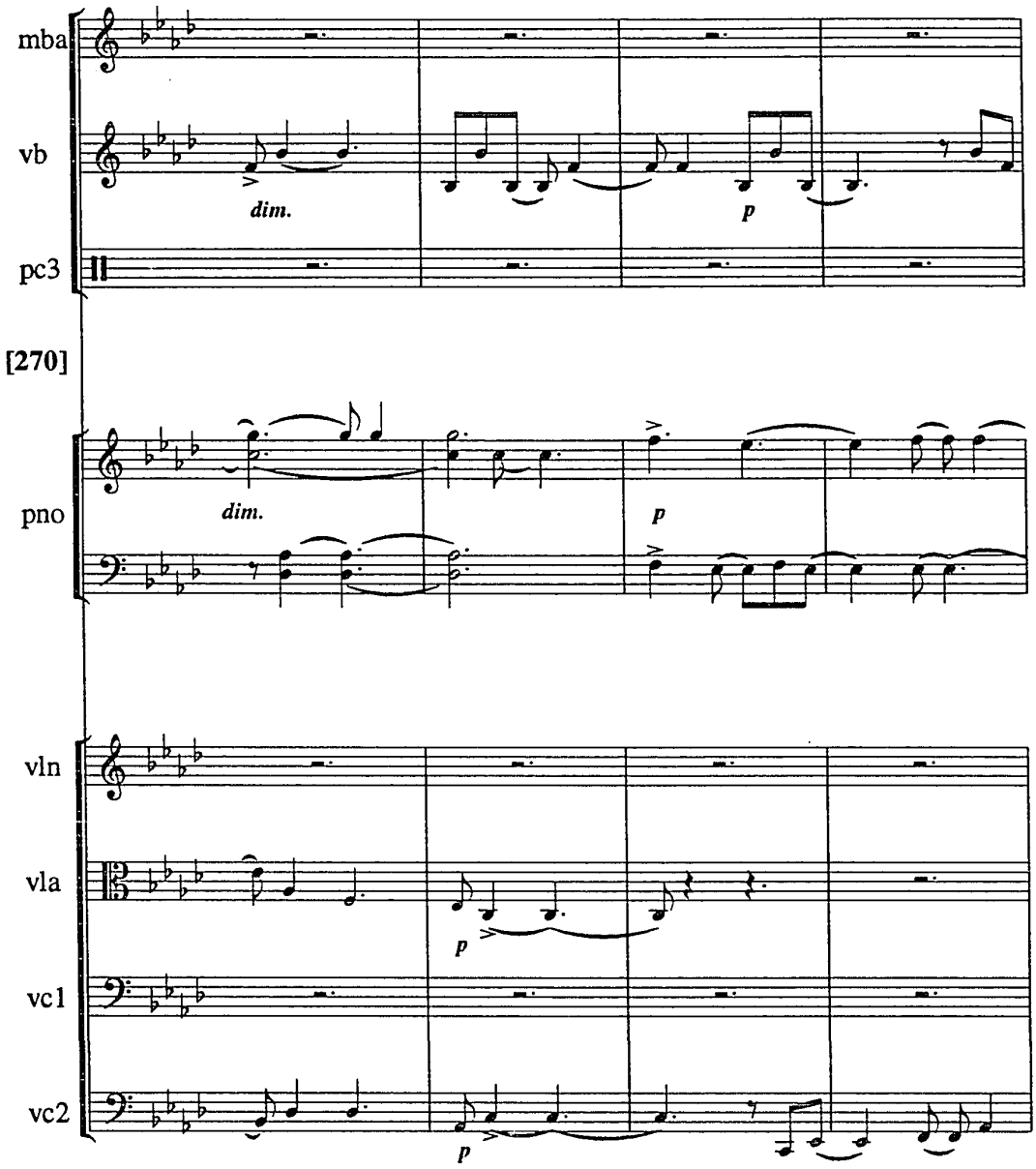

mba
vb
pc3
[250]
pno
mp
vln
vla
arco:
mf
vc1
arco:
mf
vc2

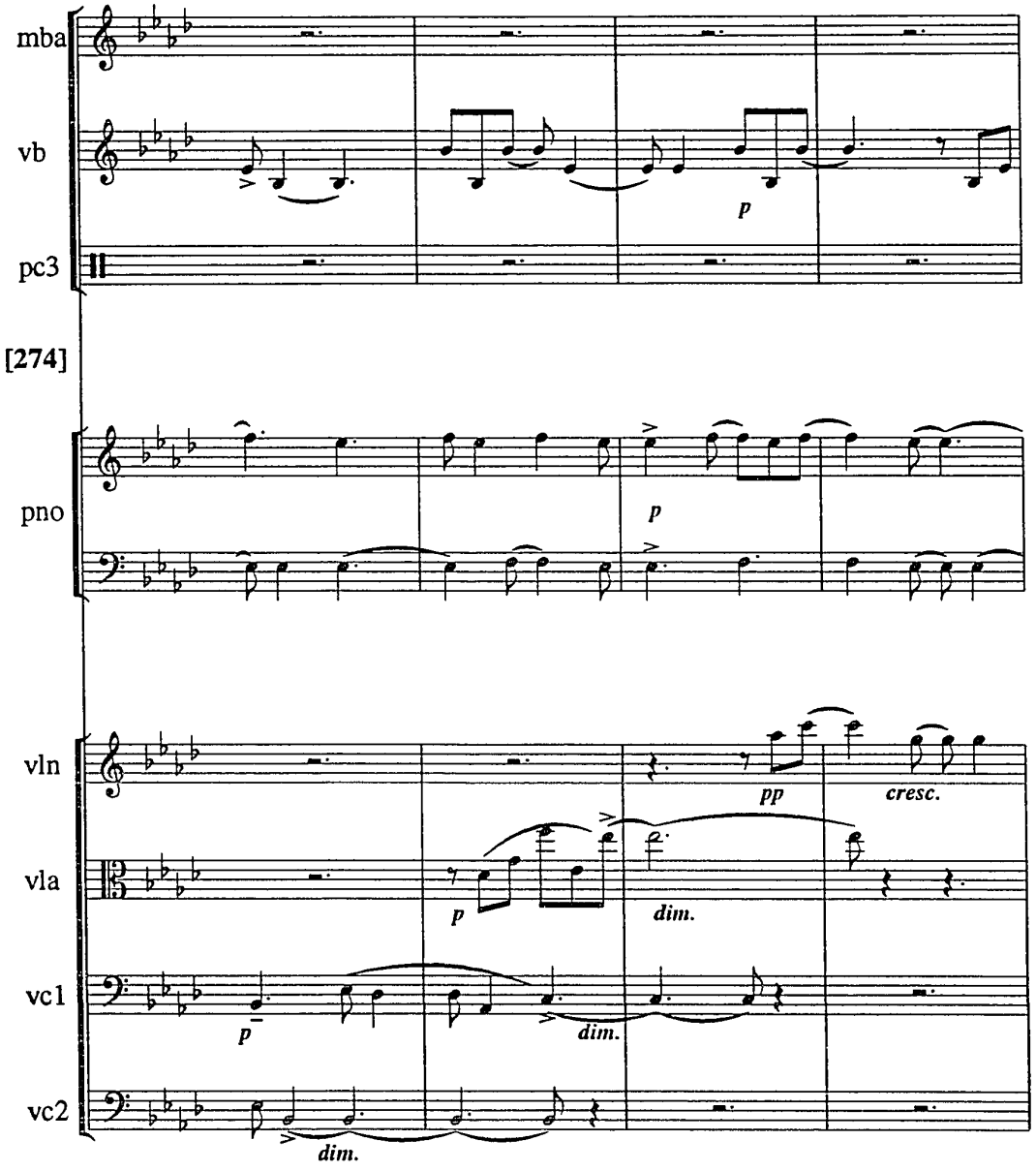

mba
vb
pc3
[254]
pno
vln
vla
vc1
vc2
mp
mf
mp
mf
mf

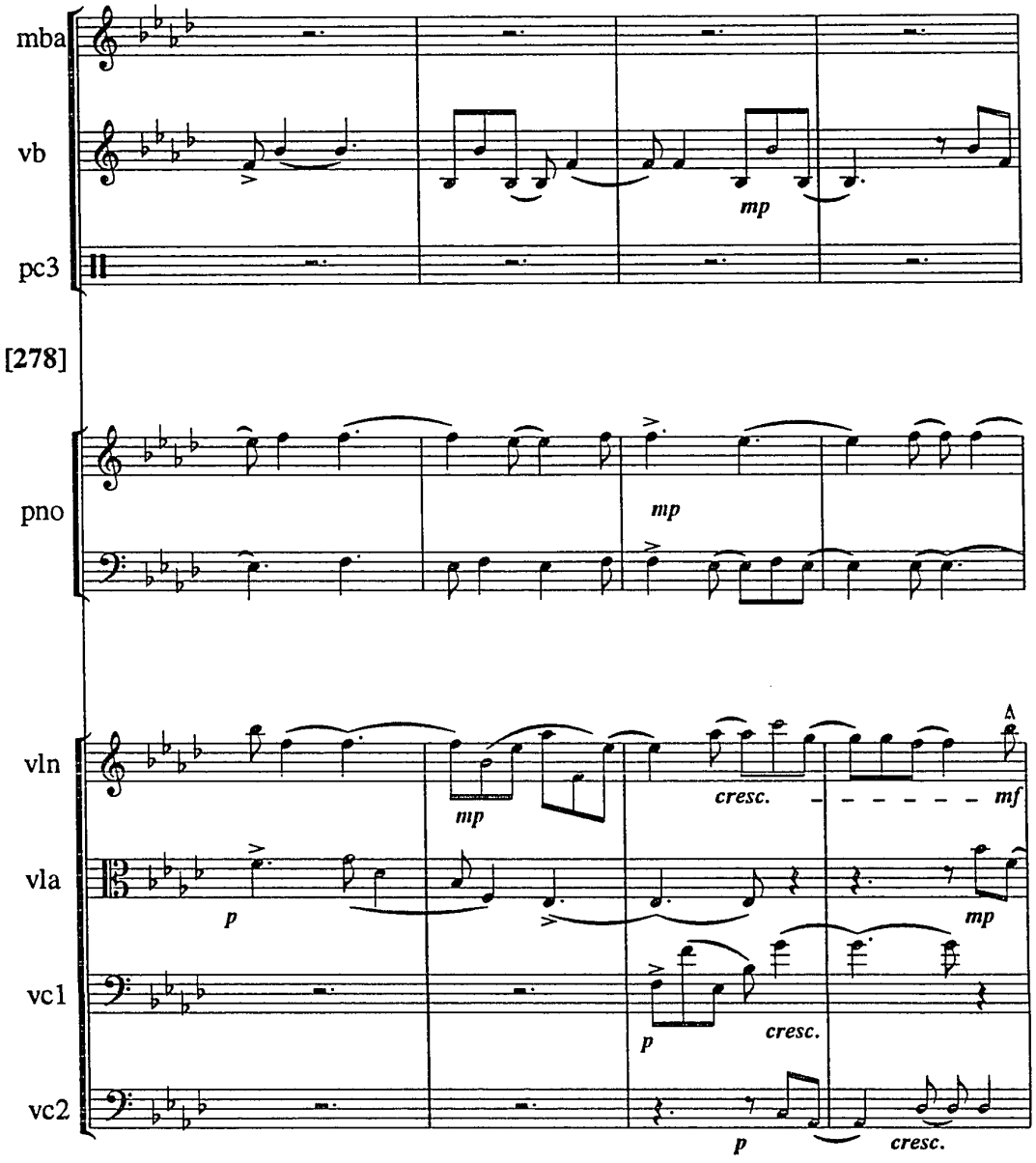

mba
vb
pc3
[258]
pno
mf
vln
vla
vc1
mf
vc2
mf

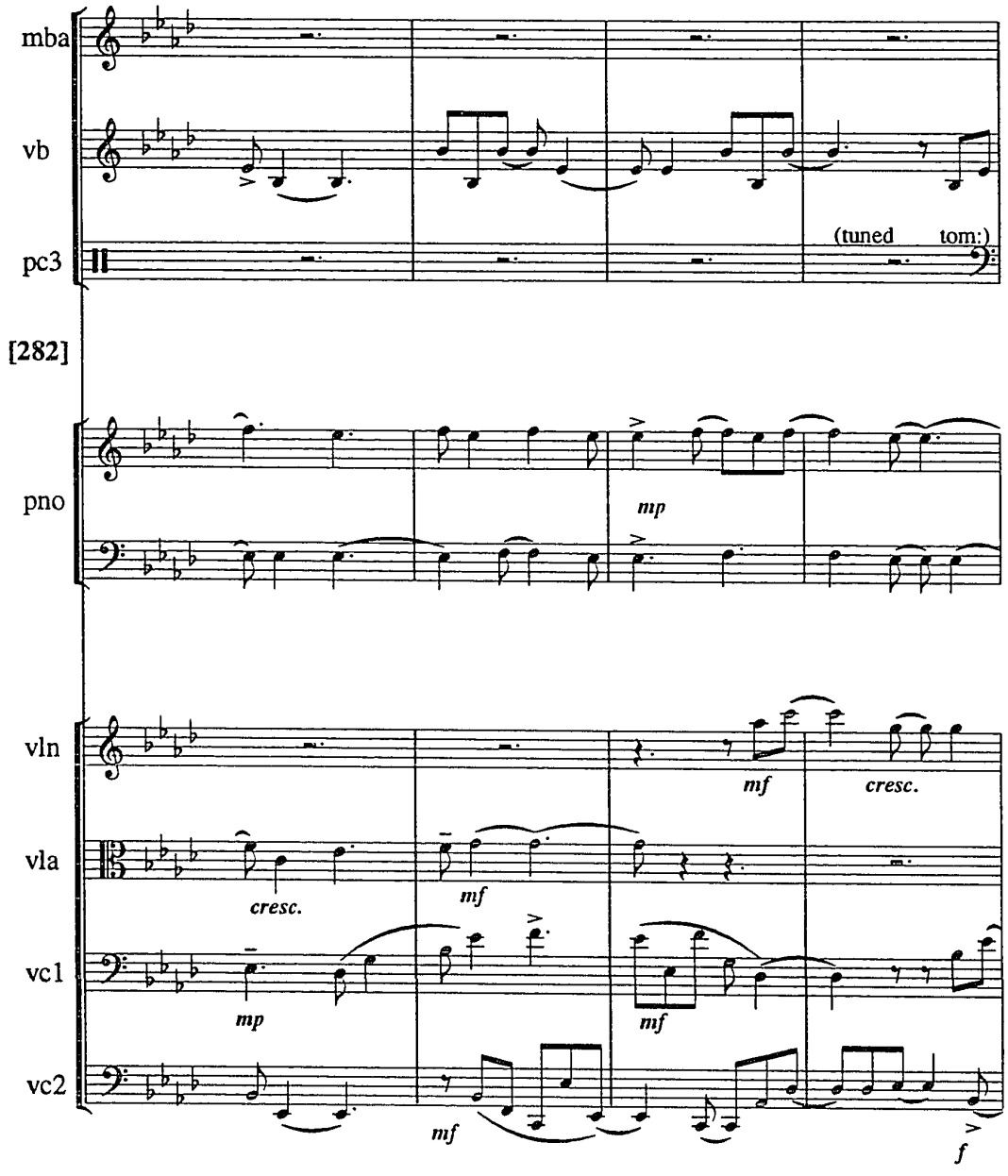

mba
vb
pc3
mf
[262]
pno
mf
vln
vla
vc1
vc2
f
cresc.
f

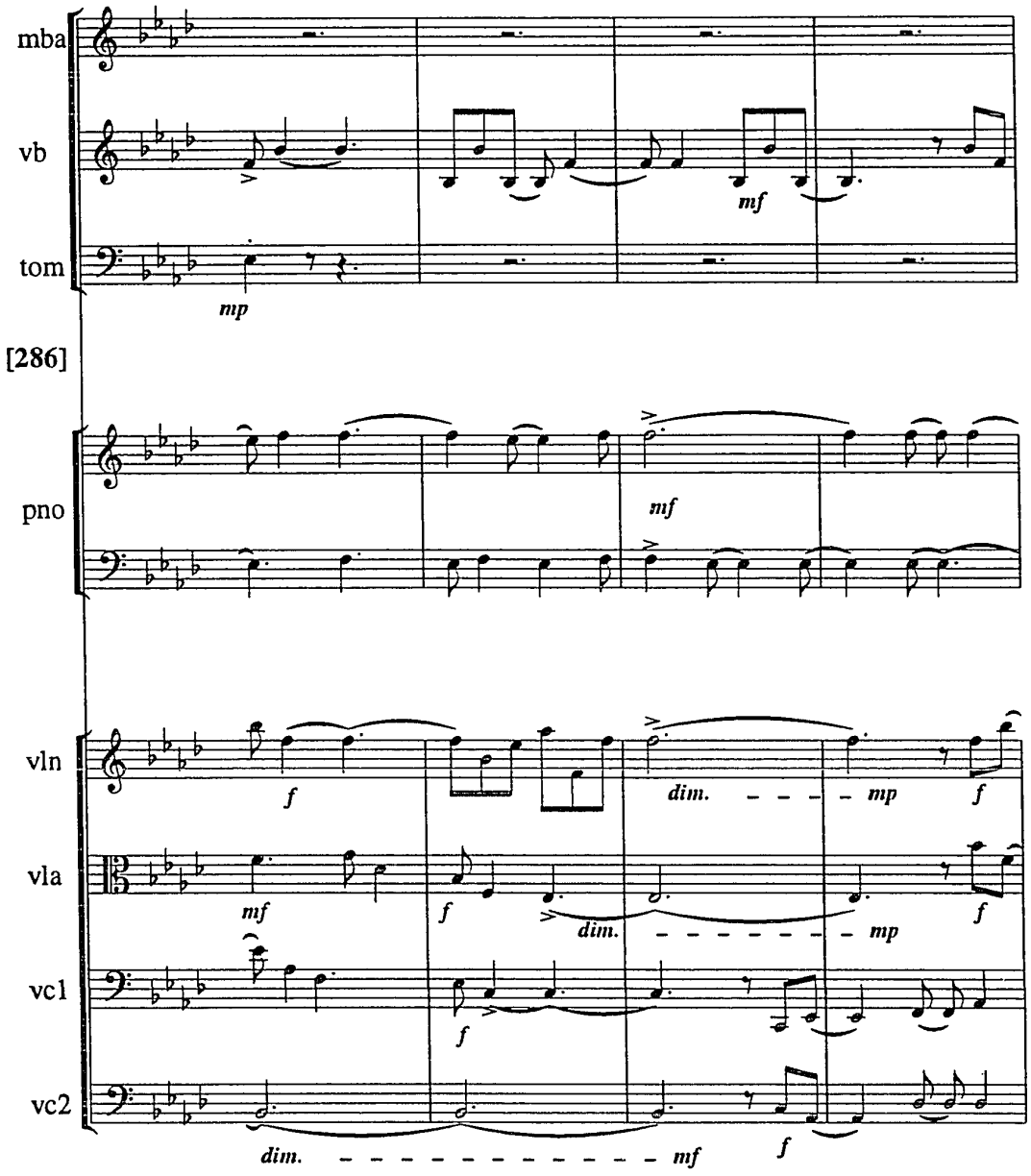

mba
vb
pc3
mf
[266]
pno
mf
vln
vla
f
dim.
vc1
vc2
f
dim.

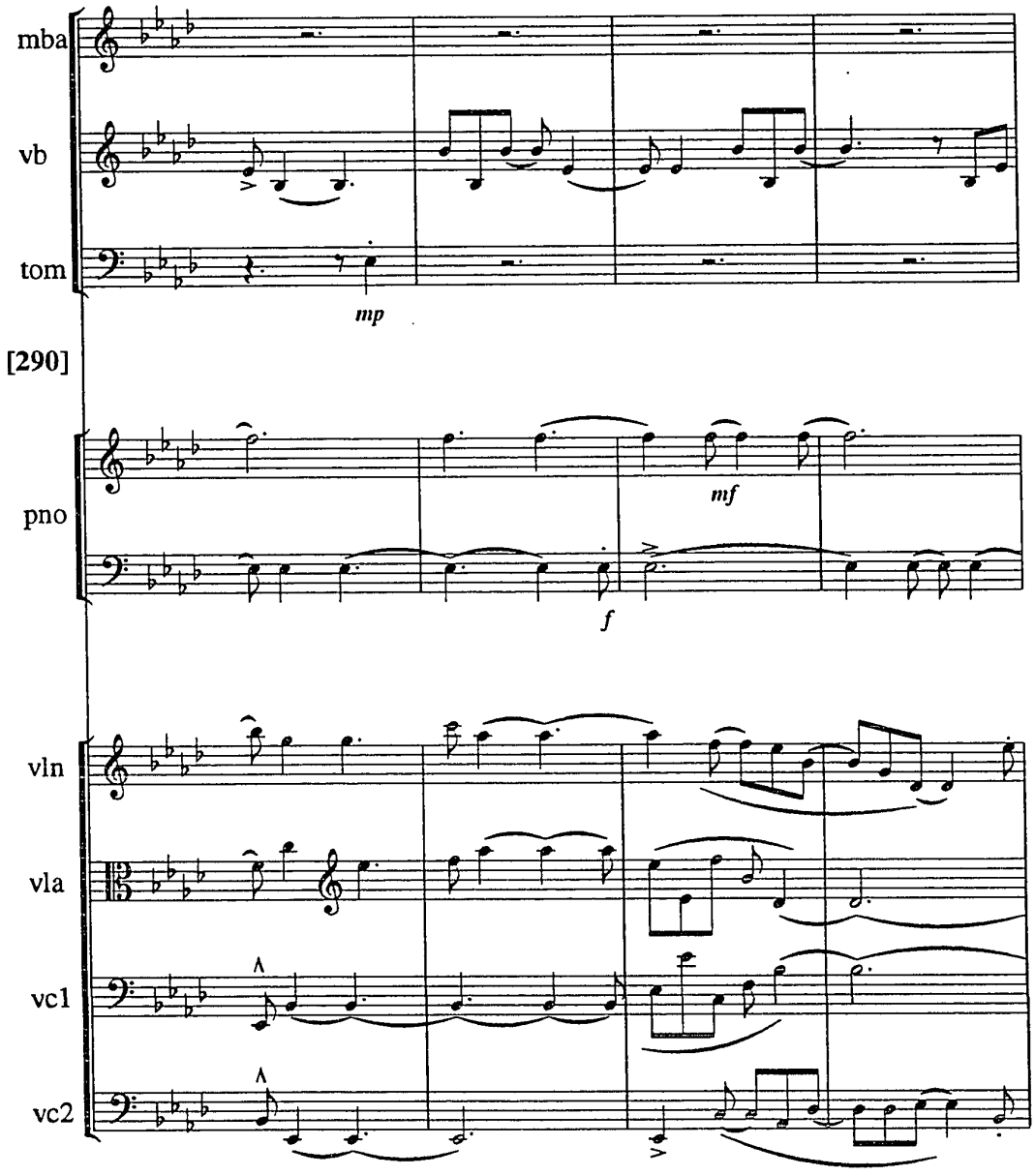

mba
vb
dim.
p
pc3
[270]
pno
dim.
p
vln
vla
p
vc1
vc2
p

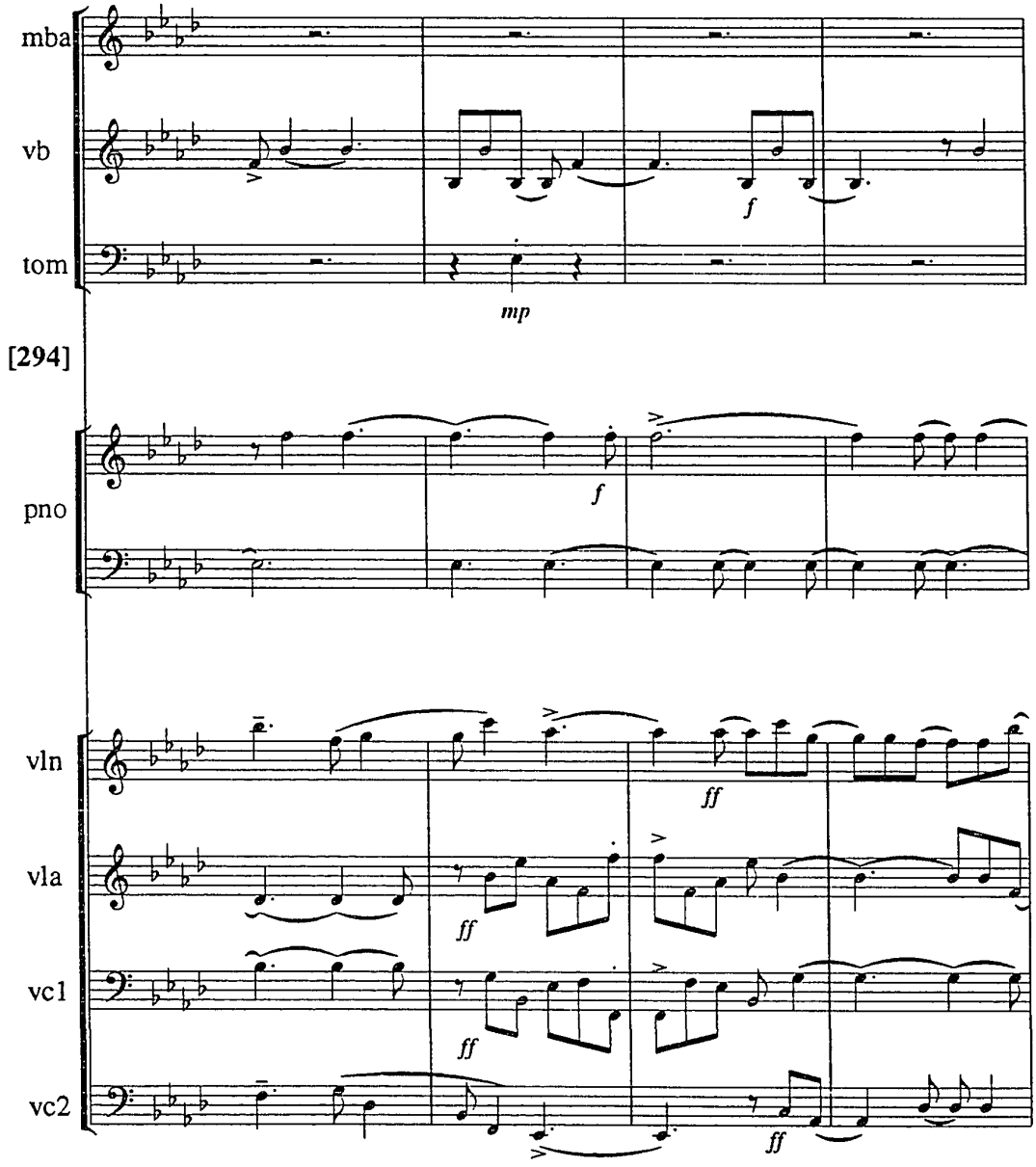

mba
vb
pc3
[274]
pno
vln
vla
vc1
vc2
p
p
pp
cresc.
p
dim.
p
dim.
dim.

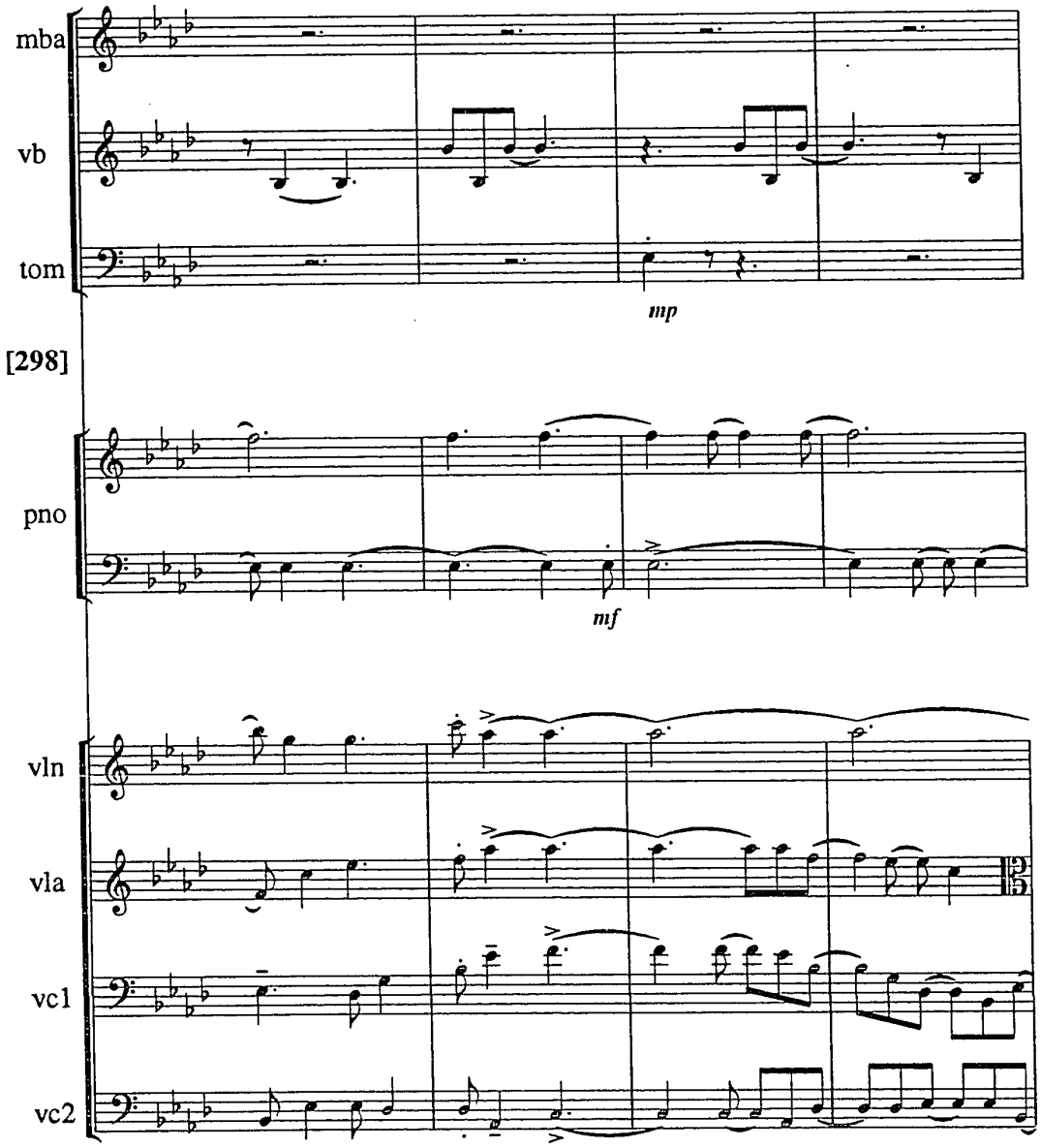

mba
vb
pc3
[278]
pno
vln
vla
vc1
vc2
mp
mp
cresc.
mf
A
p
mp
p
cresc.
p
cresc.

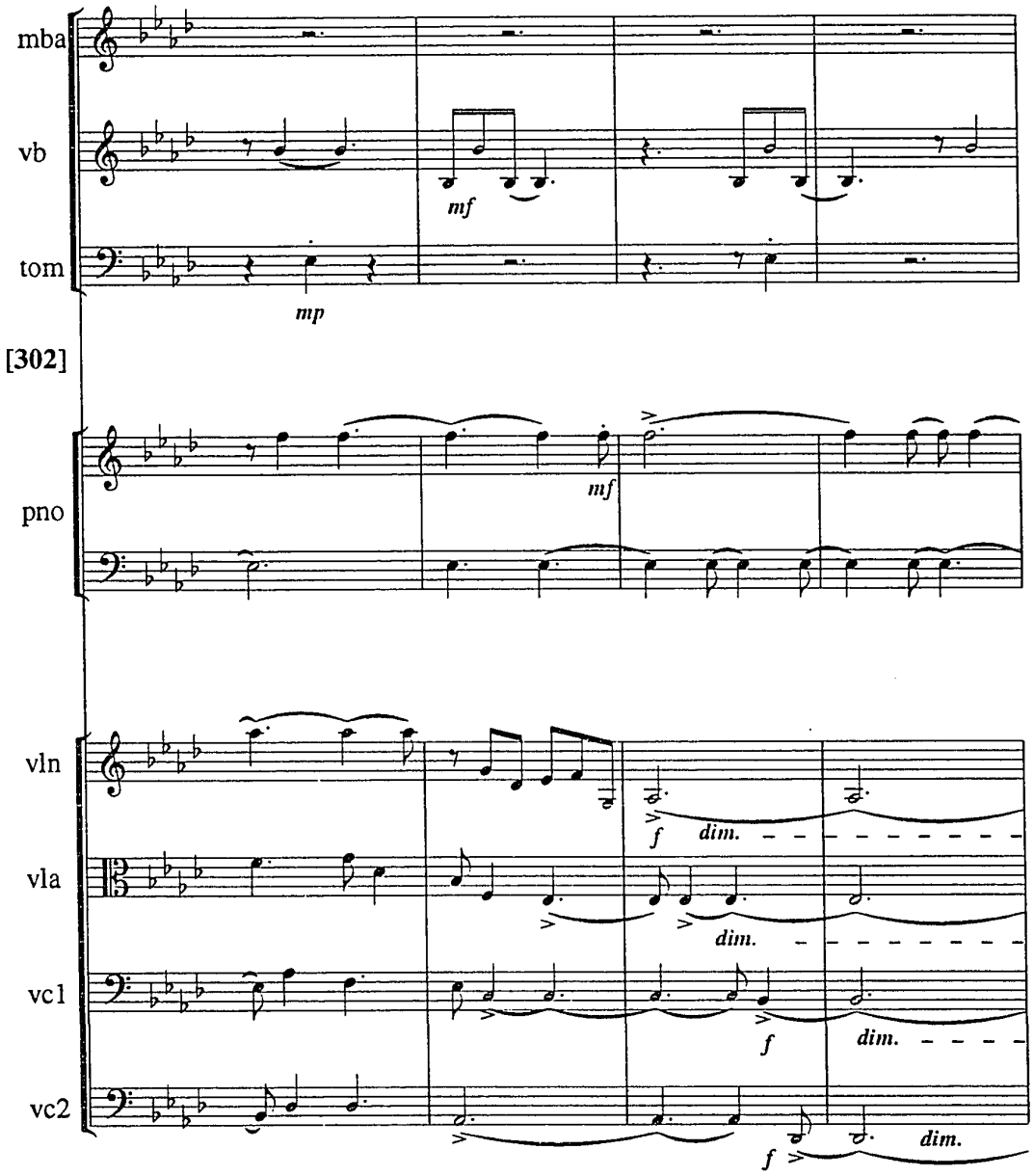

mba
vb
pc3
(tuned tom:)
[282]
pno
mp
vln
mf
cresc.
vla
cresc.
mf
vc1
mp
mf
vc2
mf
f

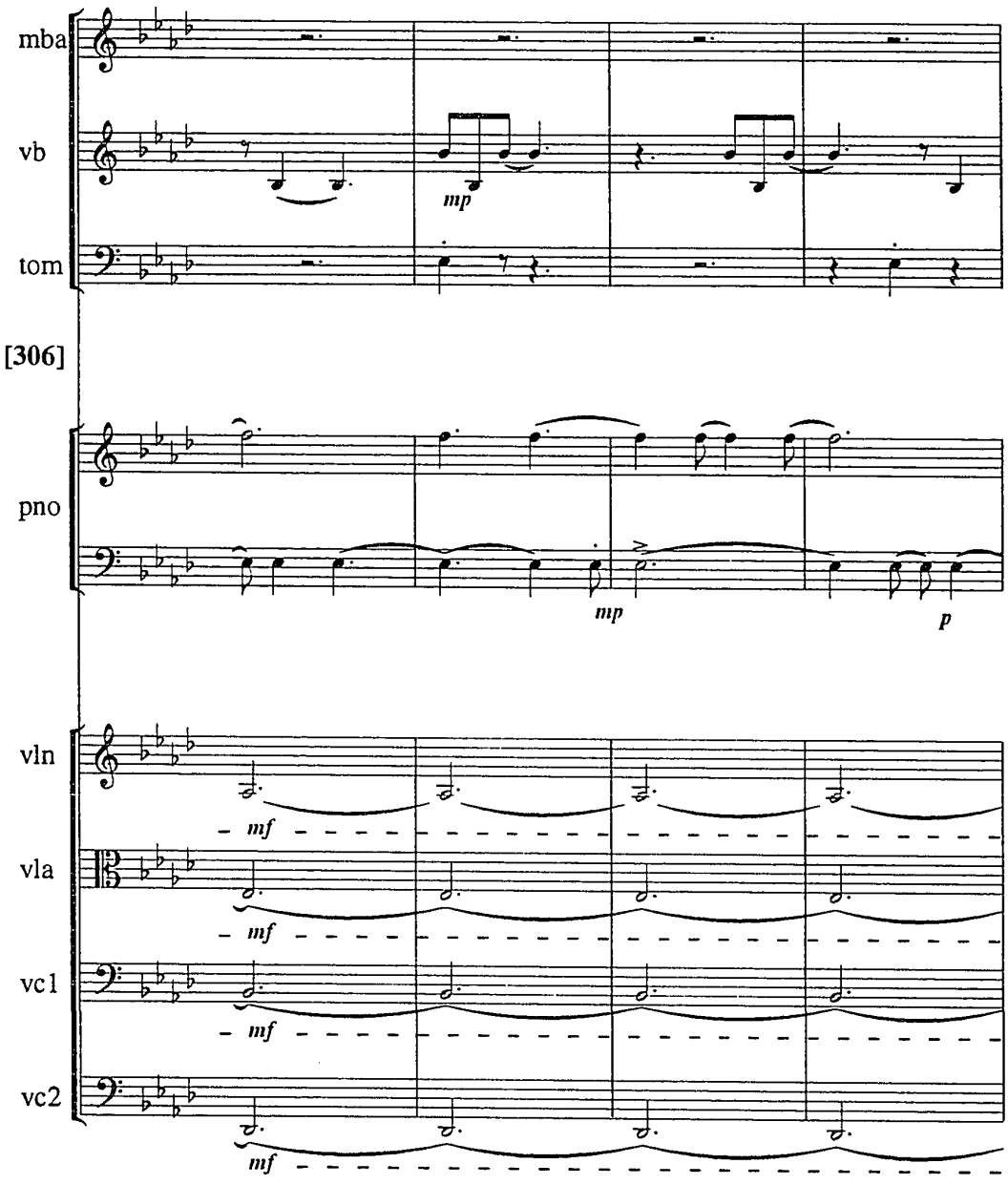

mba
vb
tom
mp
mf
[286]
pno
mf
vln
vla
vc1
vc2
f
dim.
mp
f
mf
f
dim.
mp
f
f
dim.
mf
f

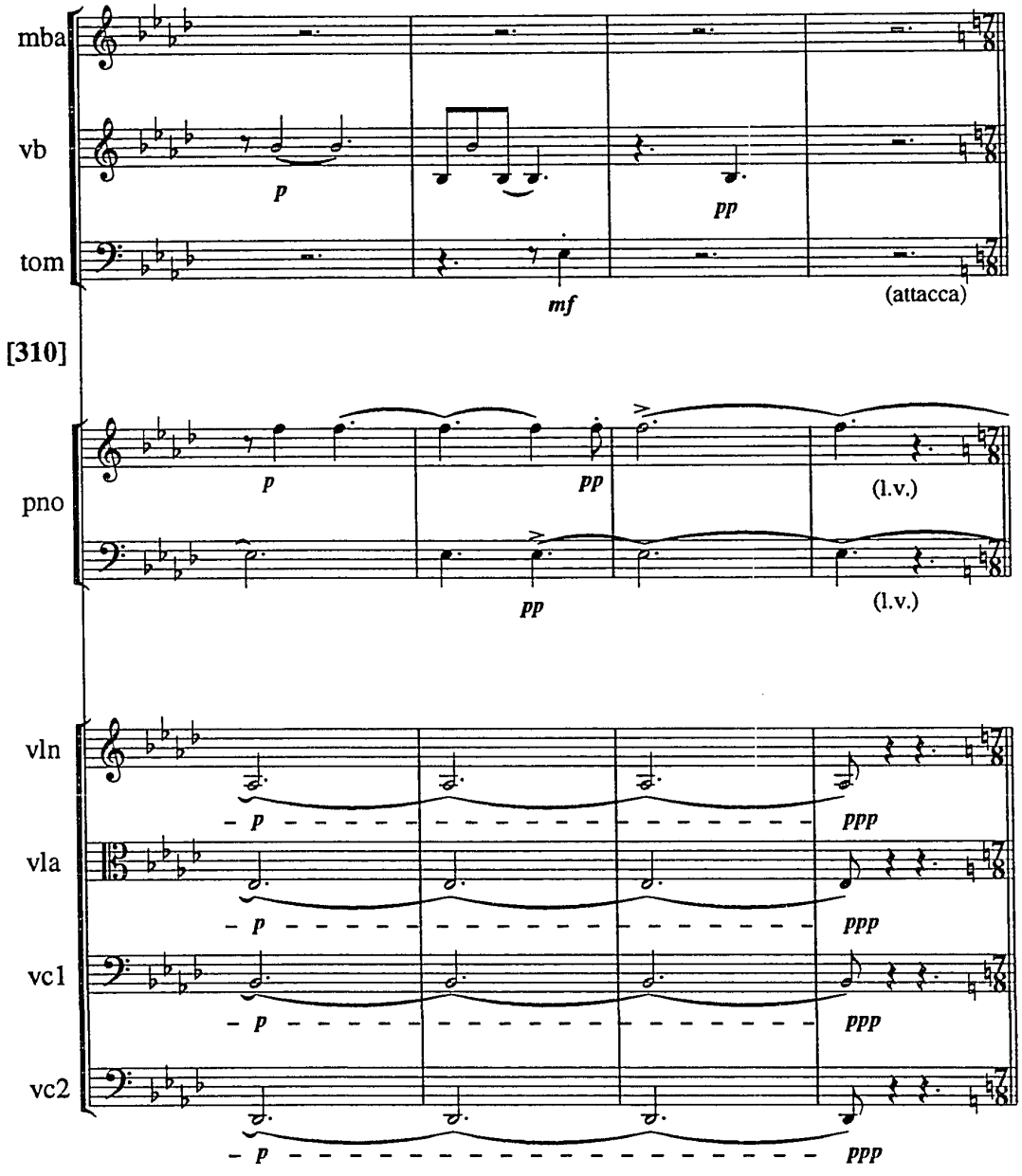

mba
vb
tom
mp
[290]
pno
mf
f
vln
vla
vc1
vc2

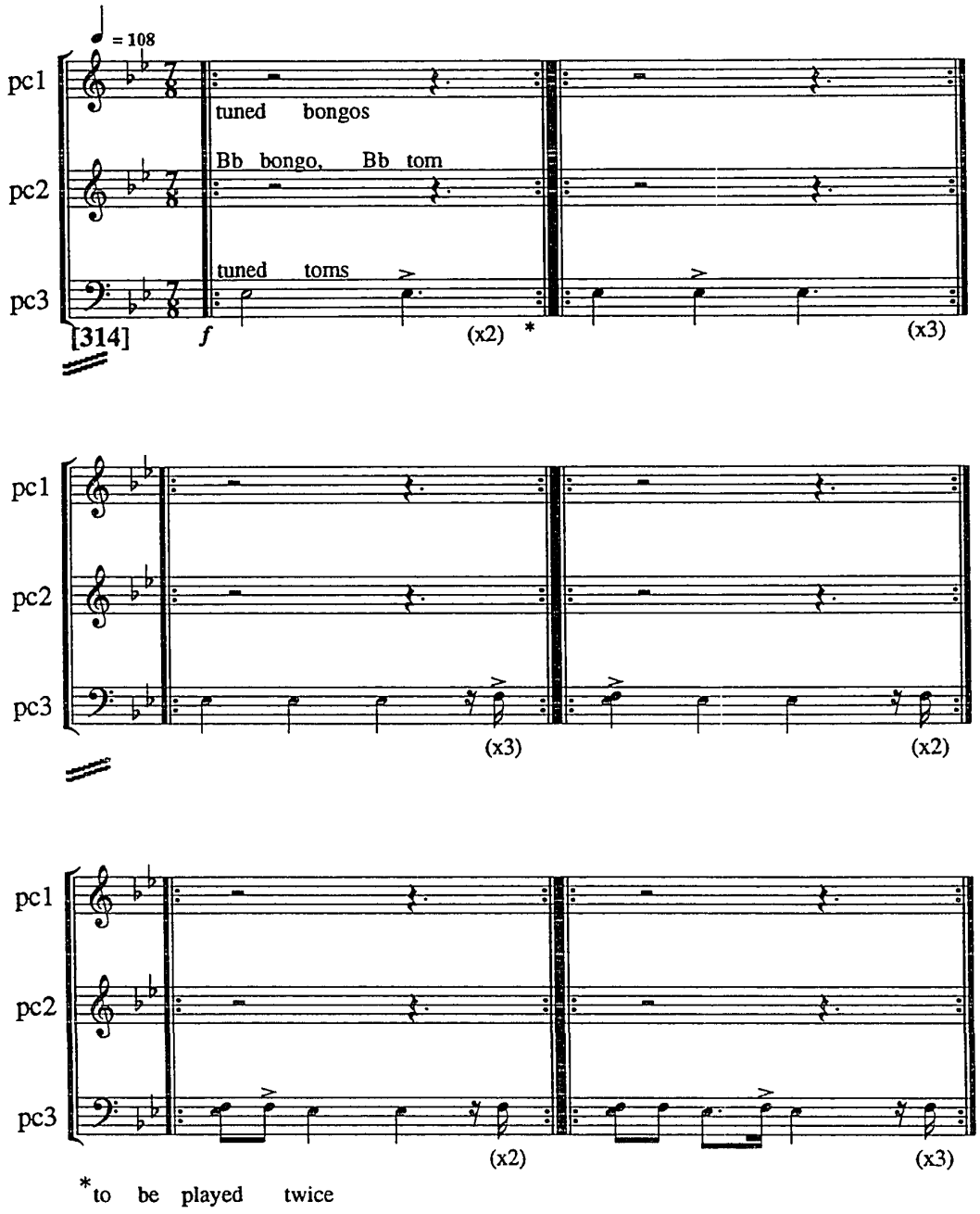

mba
vb
tom
mp
f
[294]
pno
f
vln
vla
vc1
vc2
ff
ff
ff
ff

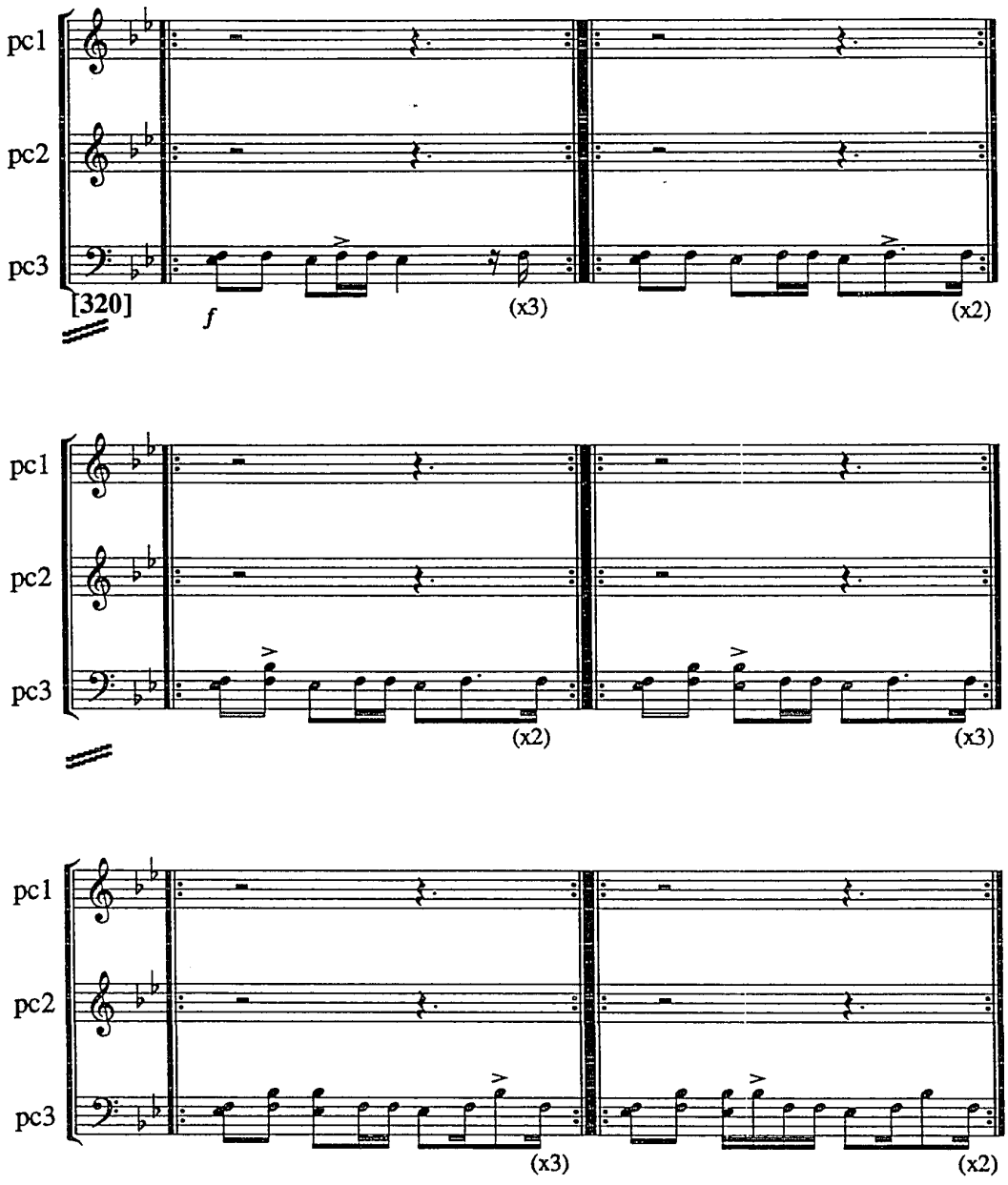

mba
vb
tom
mp
[298]
pno
mf
vln
vla
vc1
vc2

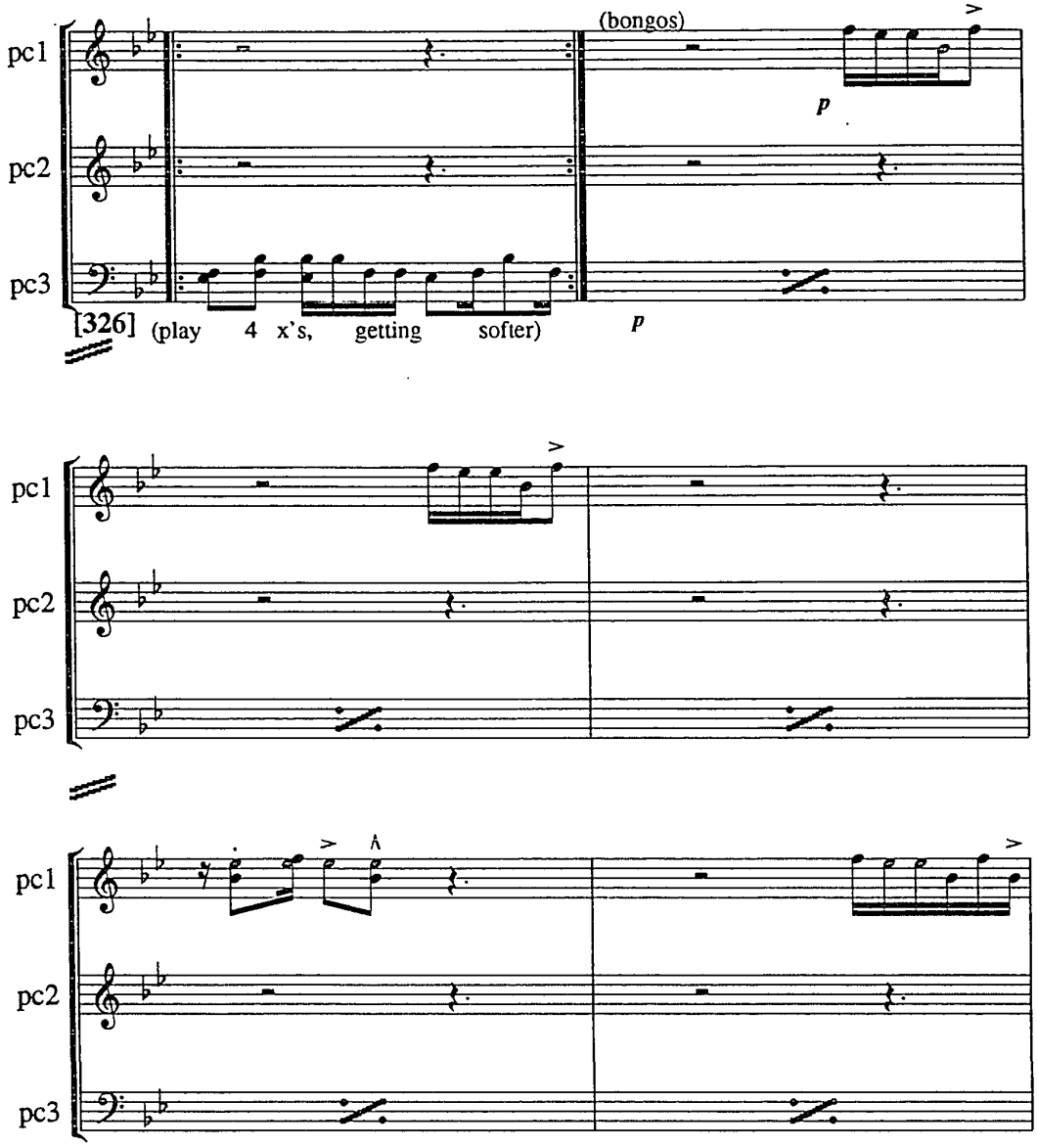

mba
vb
tom
mf
mp
[302]
pno
mf
vln
vla
vc1
vc2
f
dim.
dim.
f
dim.
f
dim.

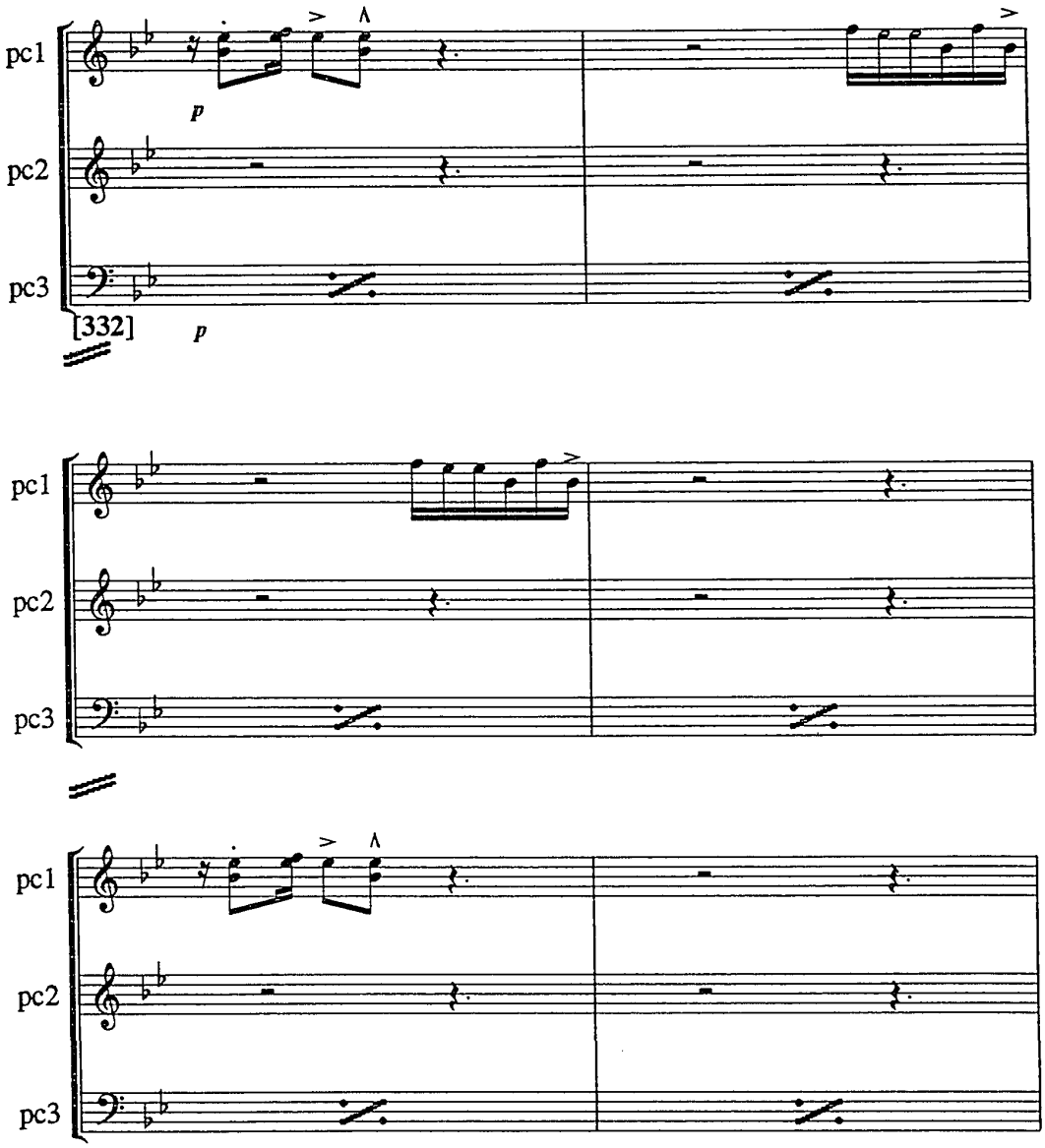

mba
vb
tom
mp
[306]
pno
mp
p
vln
mf
vla
mf
vc1
mf
vc2
mf

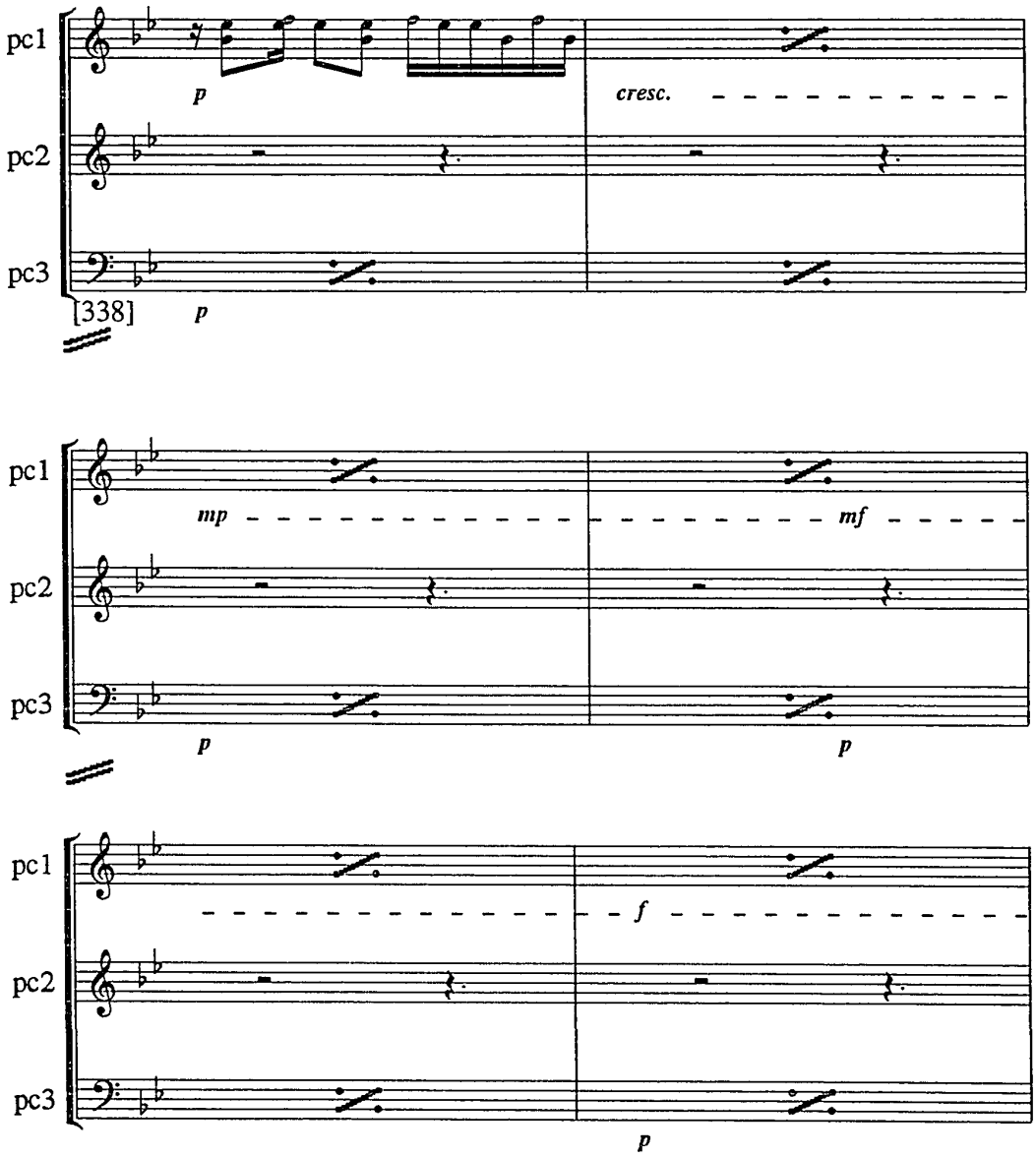

mba
vb
tom
p
pp
mf
(attacca)
[310]
pno
p
pp
(l.v.)
pp
(l.v.)
vln
vla
vc1
vc2
p
ppp

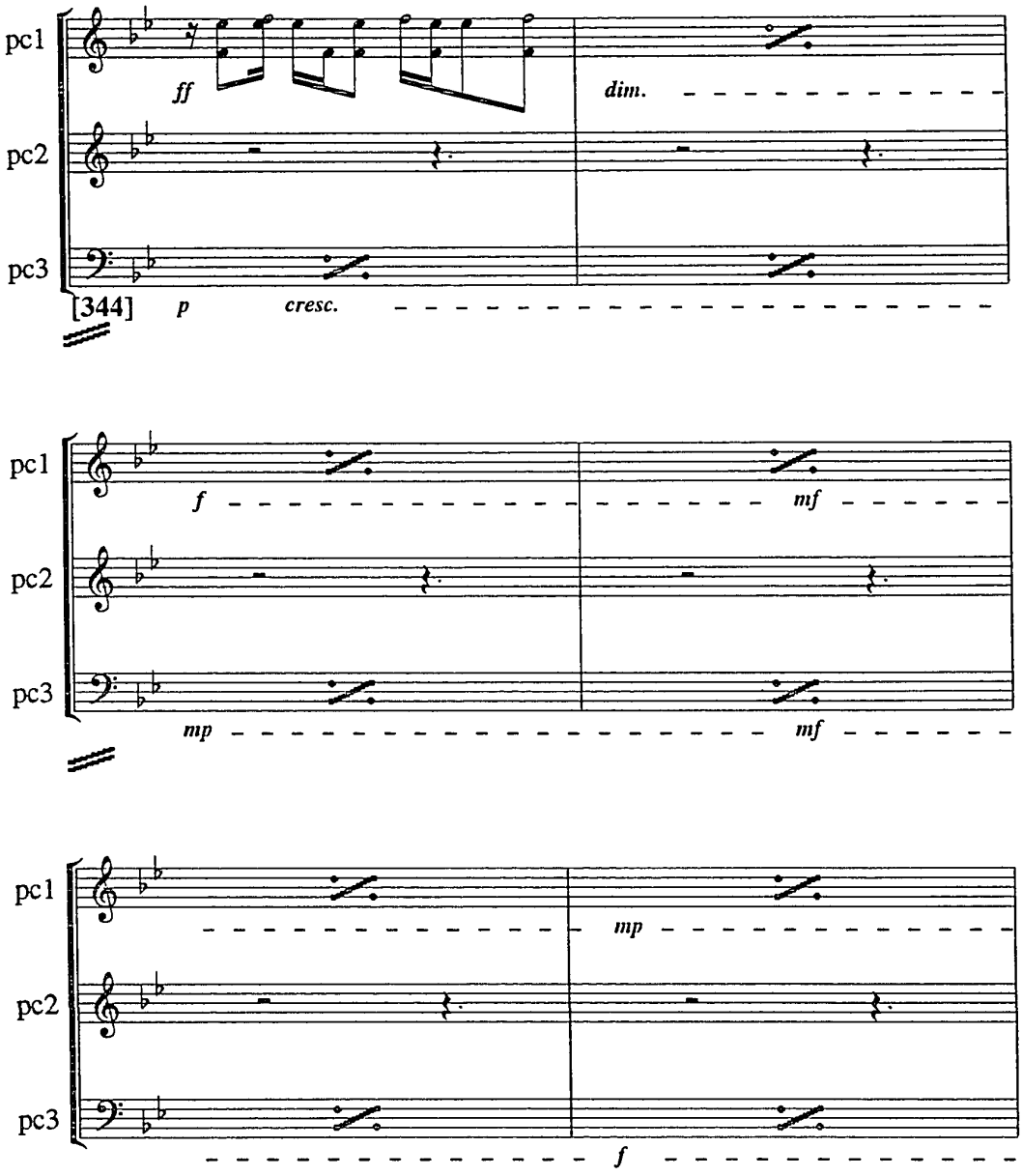

= 108
pc1
pc2
pc3
tuned bongos
Bb bongo, Bb tom
tuned toms
[314]
f
(x2)
*
(x3)
(x3)
(x2)
(x2)
(x3)
*to be played twice

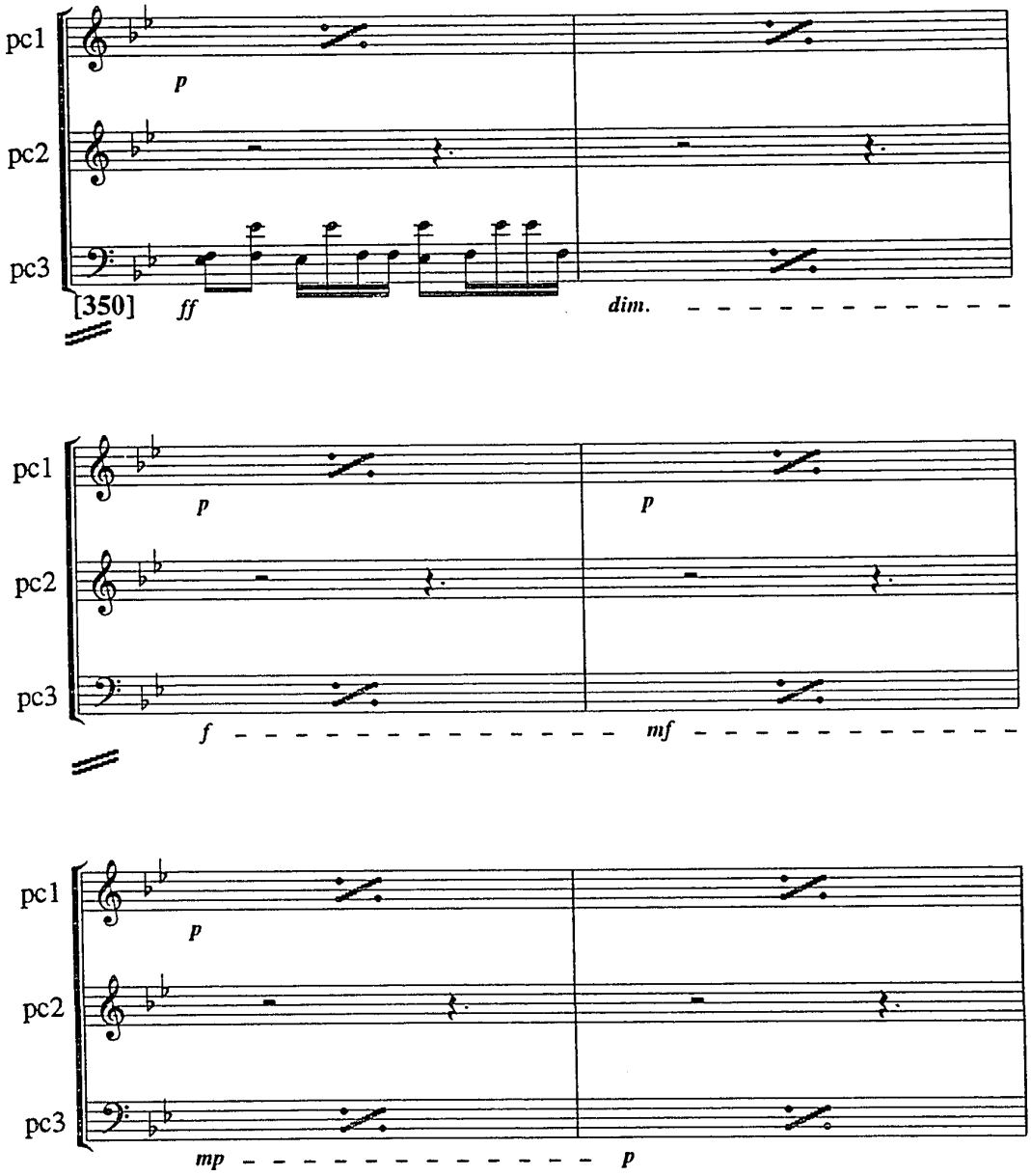

pc1
pc2
pc3
[320]
f
(x3)
(x2)
pc1
pc2
pc3
(x2)
(x3)
pc1
pc2
pc3
(x3)
(x2)

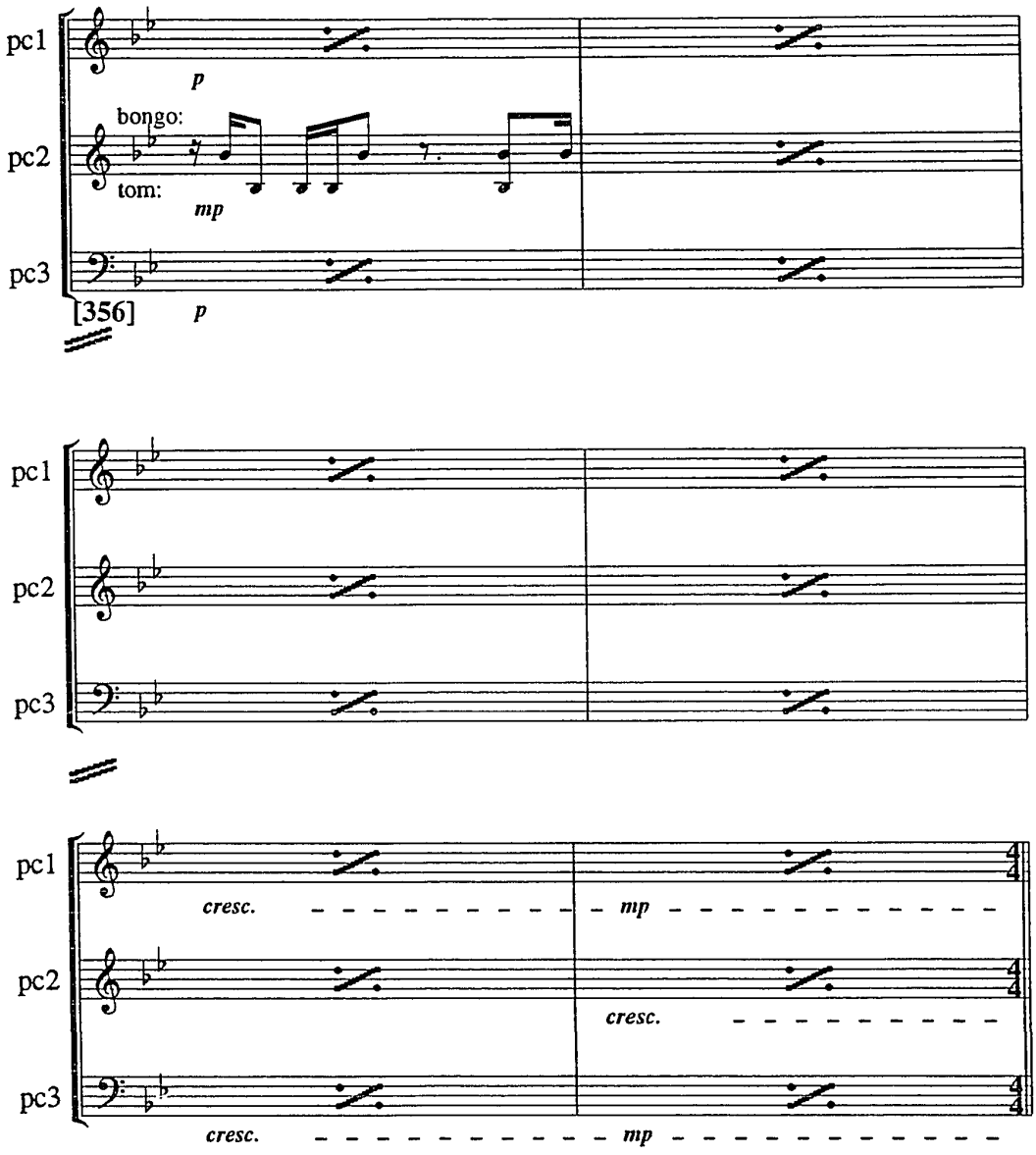

pc1
pc2
pc3
(bongos)
p
[326] (play 4 x's, getting softer)
p
pc1
pc2
pc3
pc1
pc2
pc3

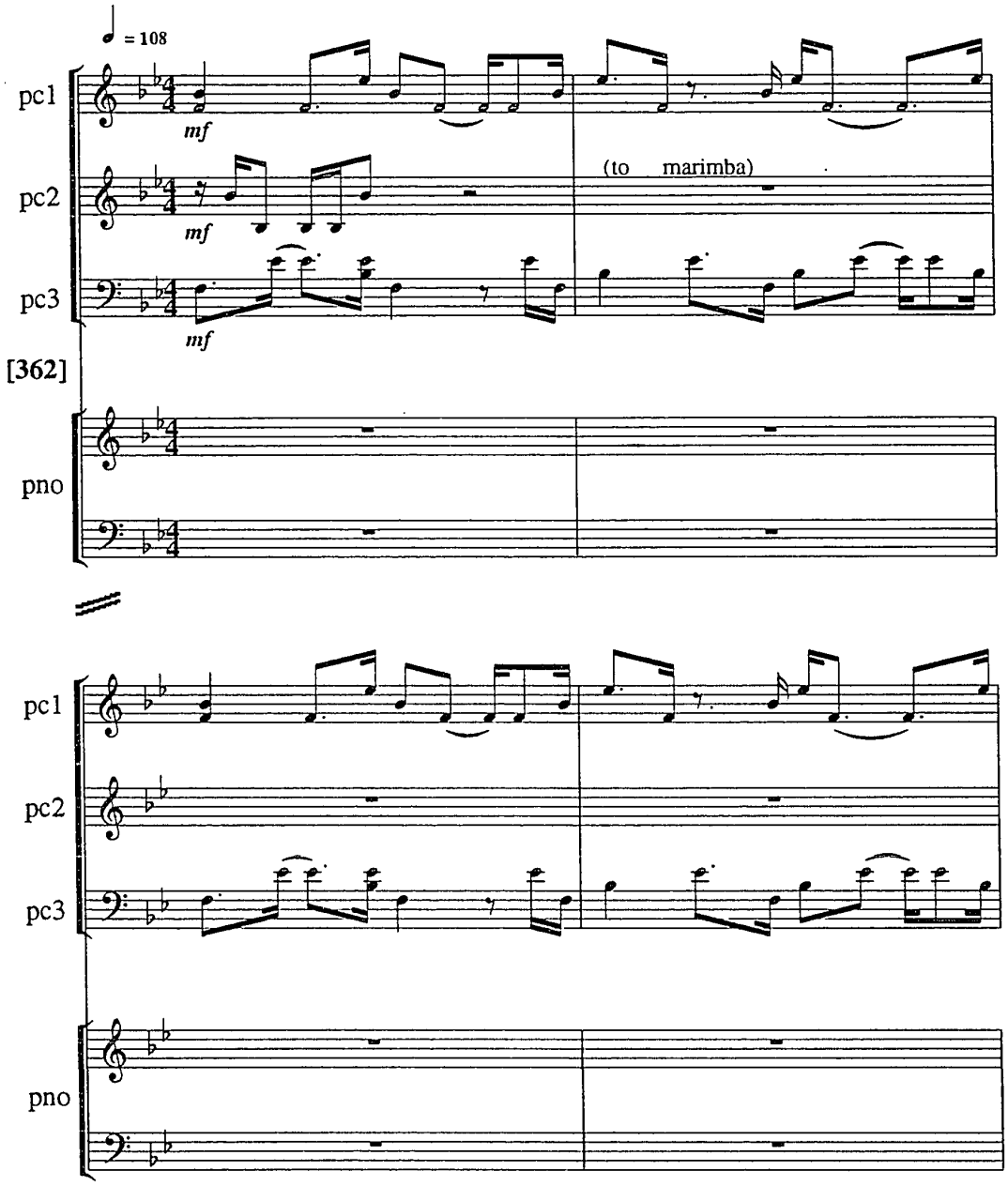

pc1
pc2
pc3
p
[332]
p
pc1
pc2
pc3
pc1
pc2
pc3

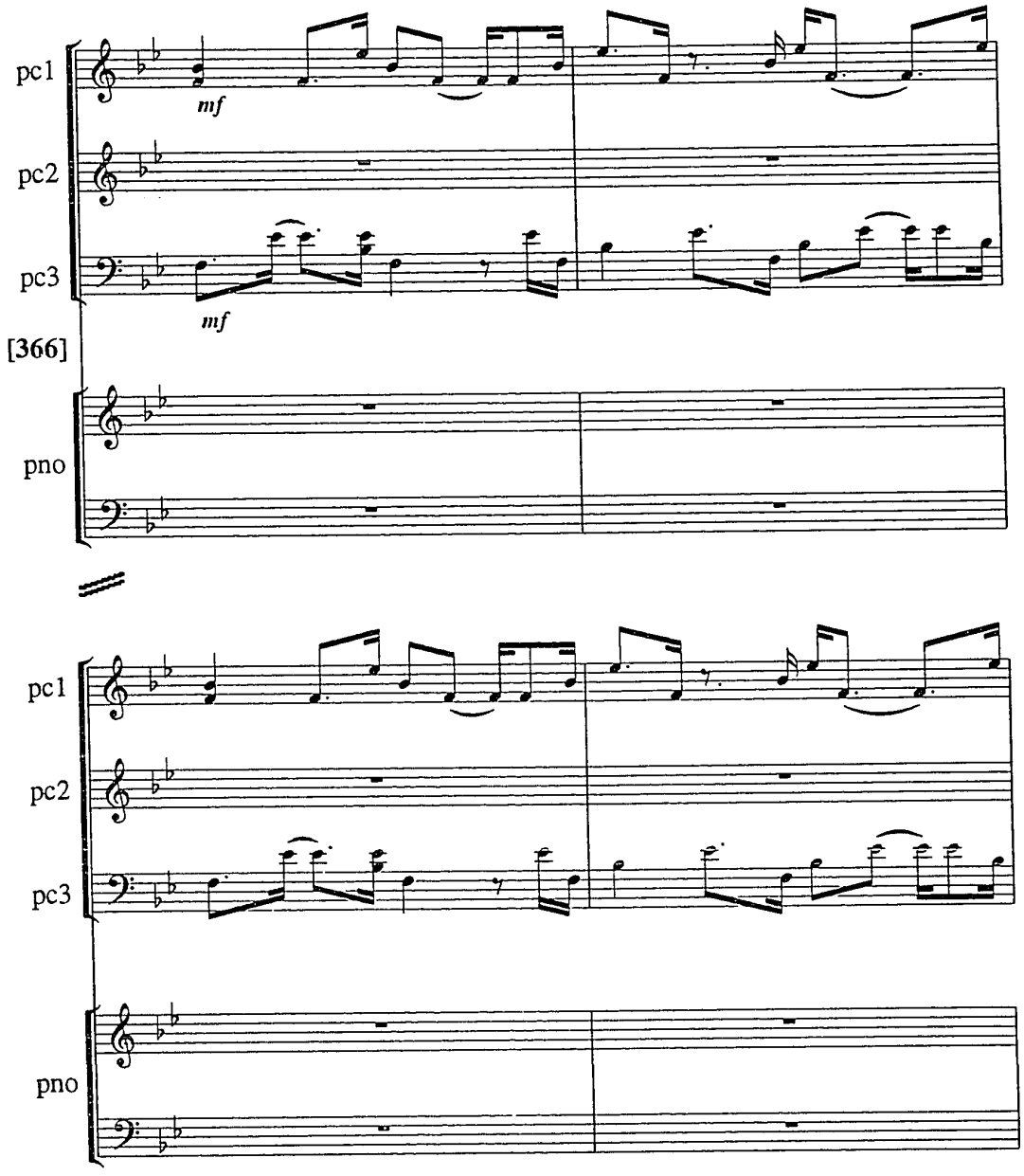

pc1
pc2
pc3
p
cresc.
[338]
p
pc1
pc2
pc3
mp
mf
p
p
pc1
pc2
pc3
f
p

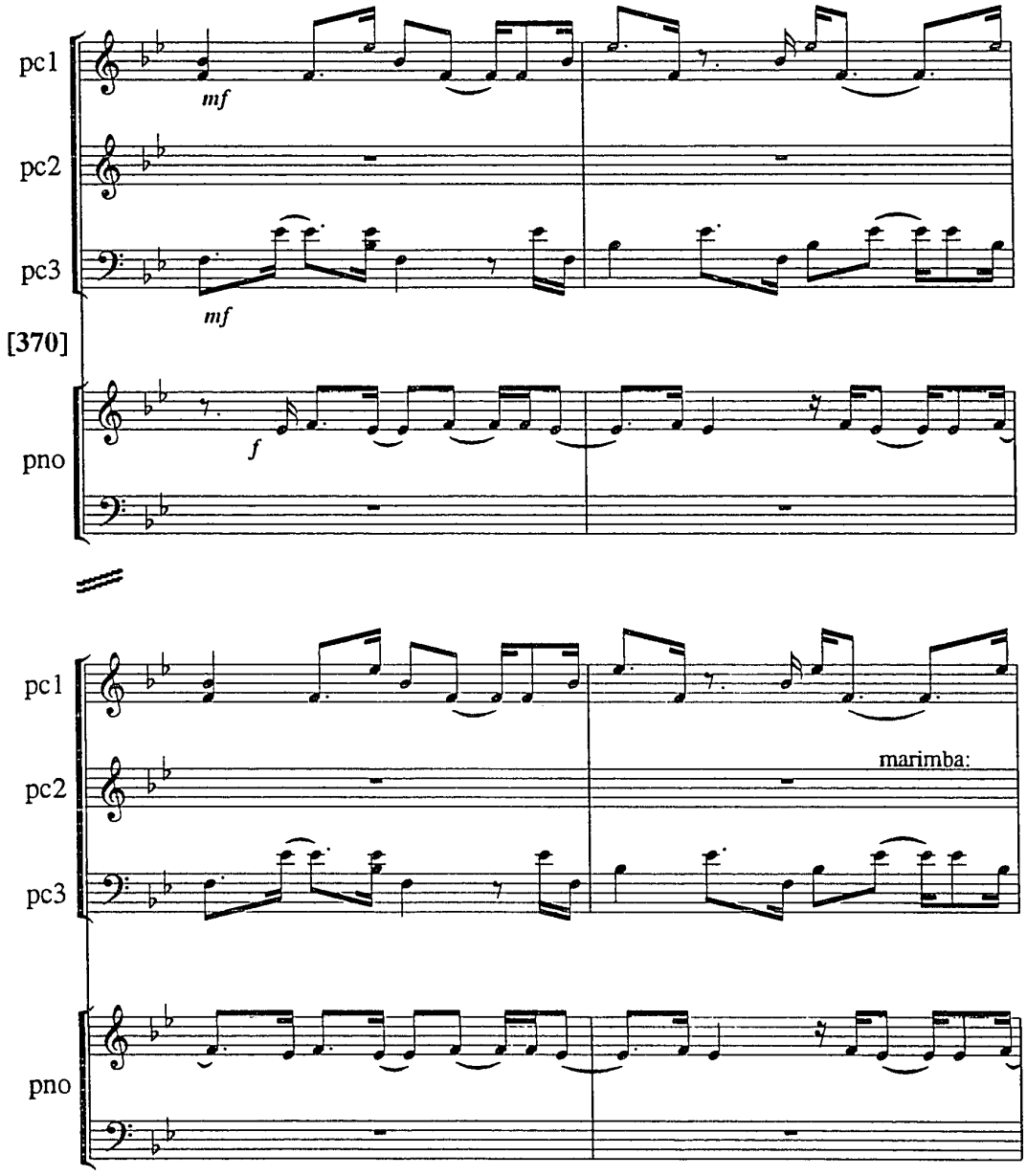

pc1
pc2
pc3
ff
dim.
[344]
p
cresc.
f
mf
mp
mf
mp
f

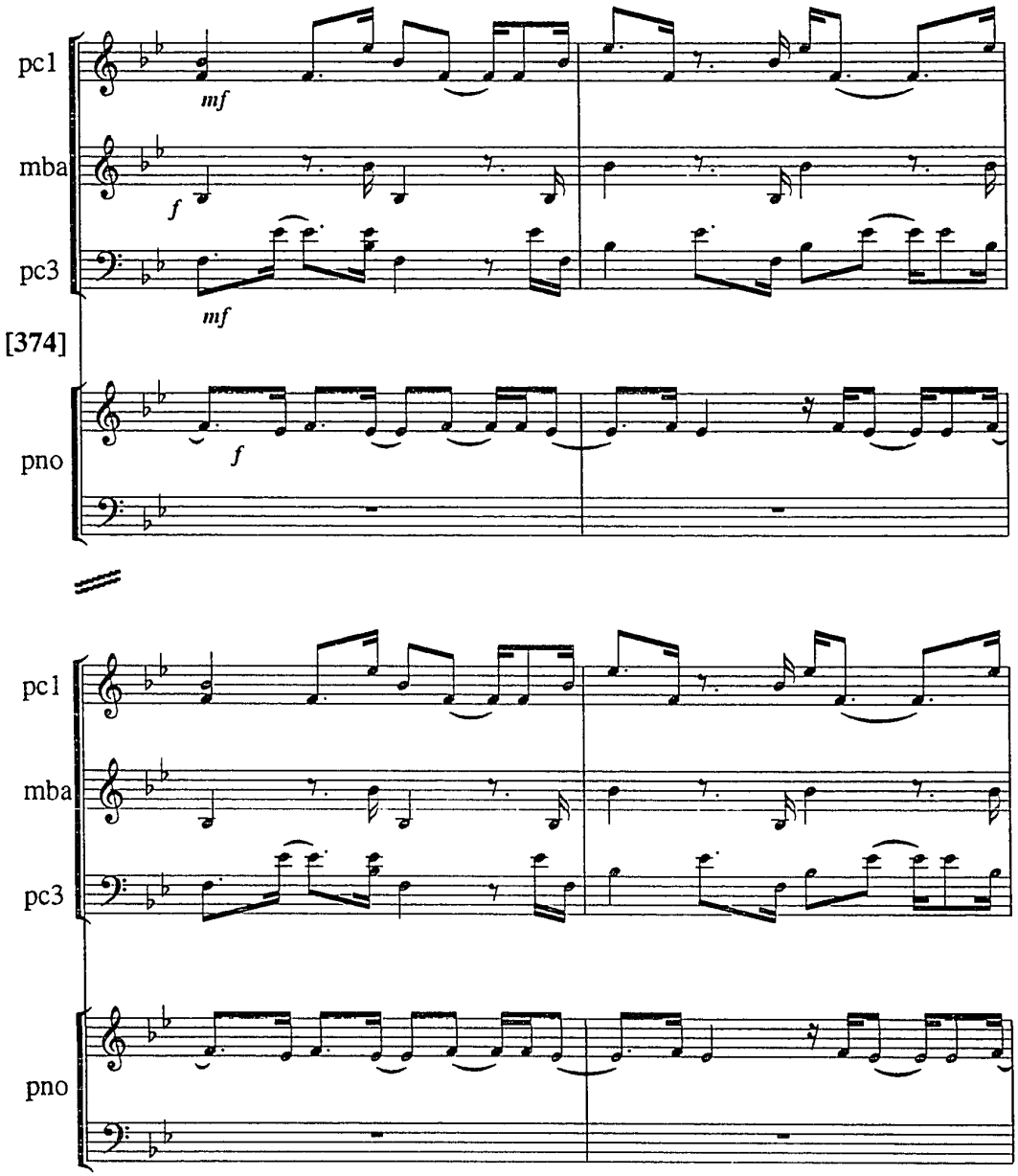

pc1
pc2
pc3
p
[350]
ff
dim.
pc1
pc2
pc3
p
p
f
mf
pc1
pc2
pc3
p
mp
p

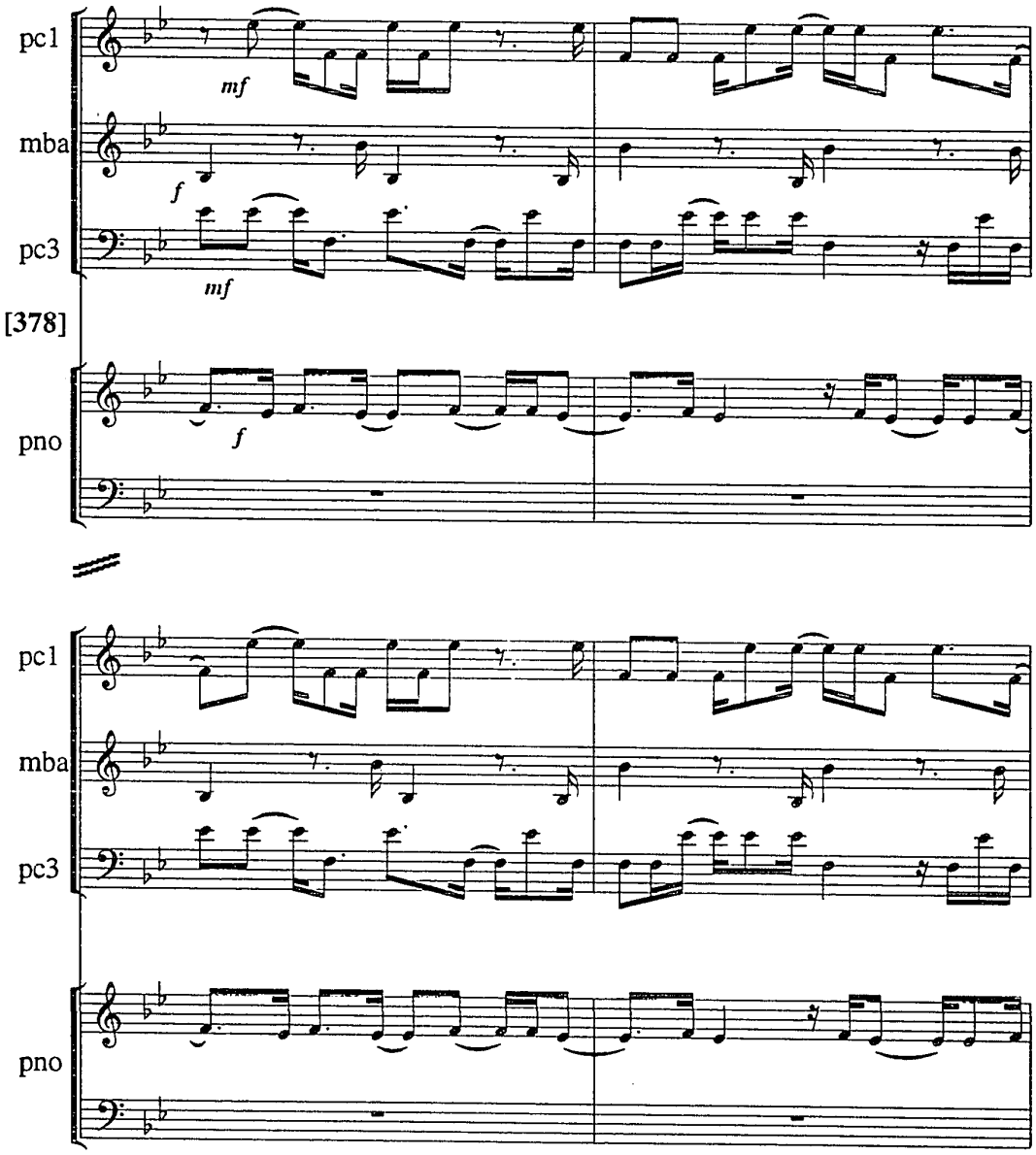

pc1
p
bongo:
pc2
tom:
mp
pc3
[356]
p
pc1
pc2
pc3
pc1
cresc.
mp
pc2
cresc.
pc3
cresc.
mp

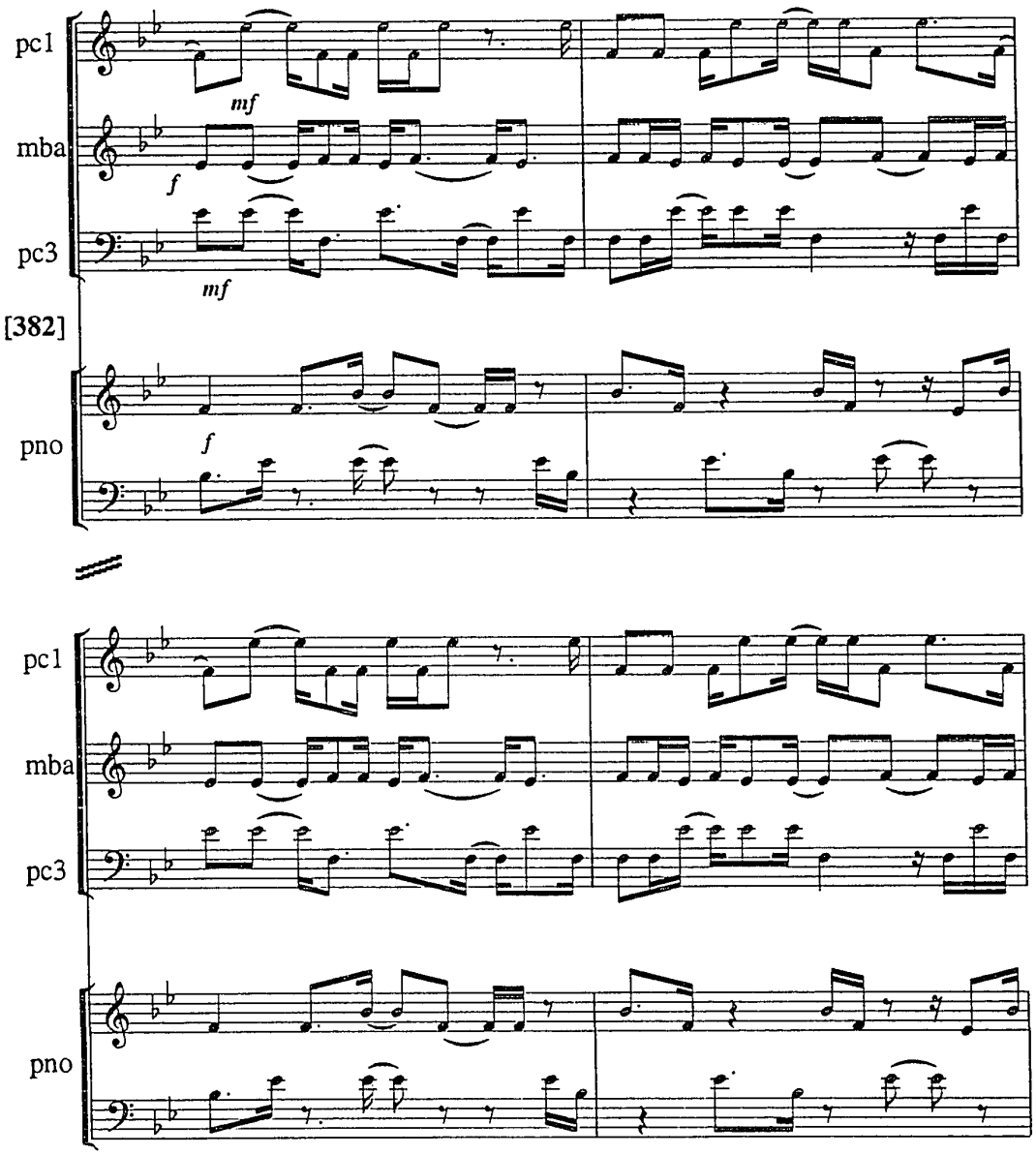

= 108
pc1
mf
pc2
mf
(to marimba)
pc3
mf
[362]
pno
pc1
pc2
pc3
pno

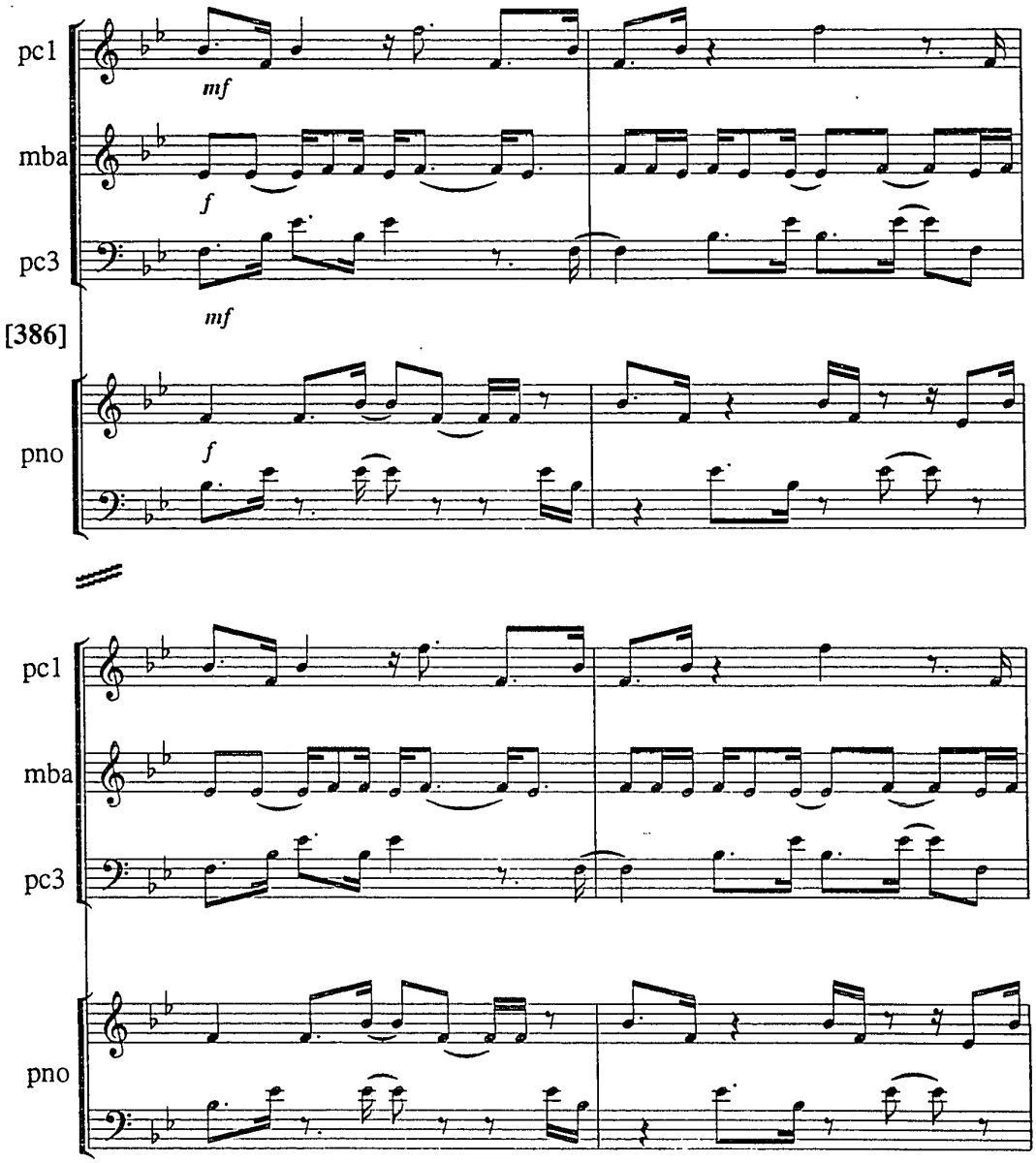

pc1
pc2
pc3
mf
mf
[366]
pno
pc1
pc2
pc3
pno

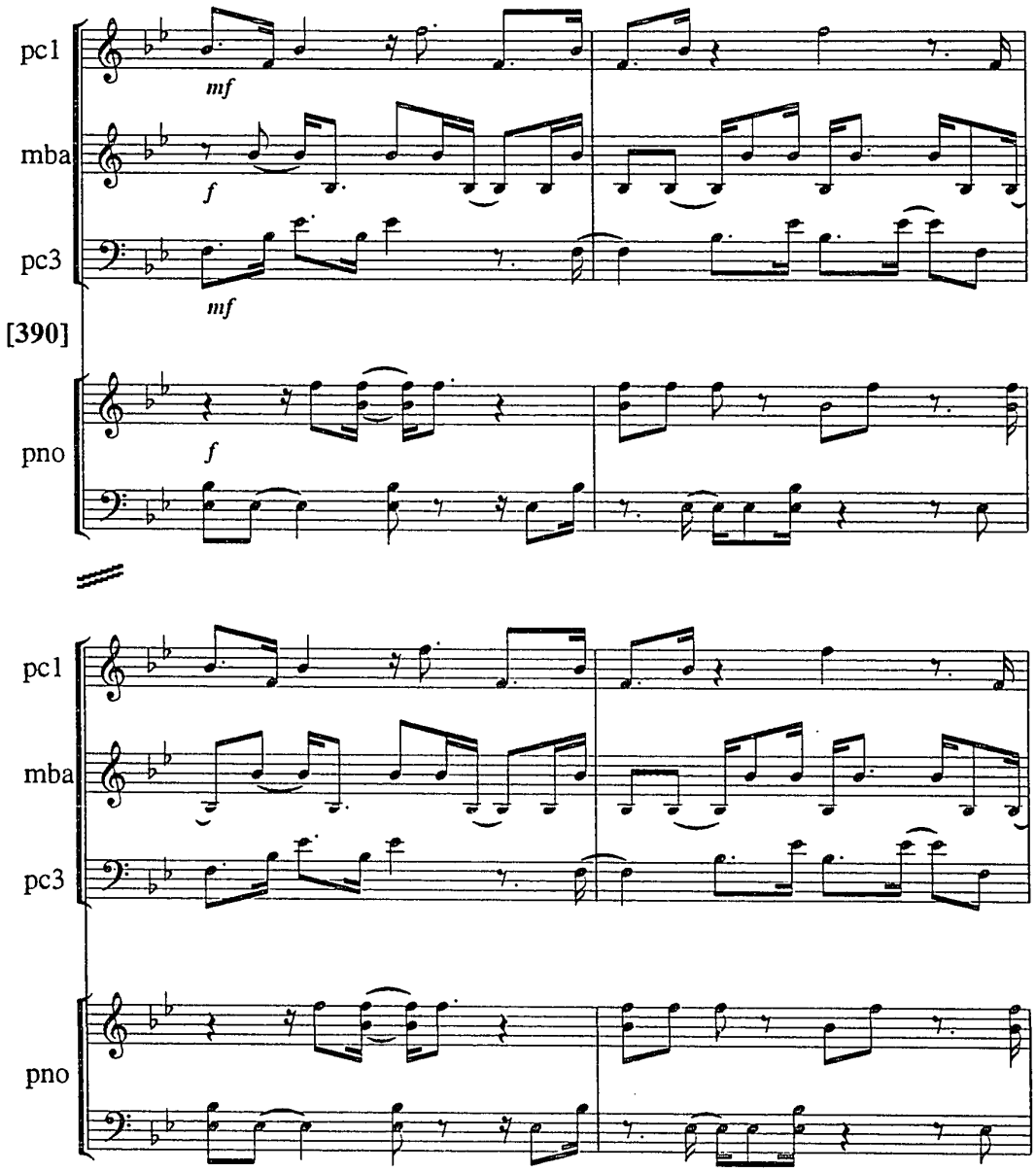

pc1
mf
pc2
pc3
mf
[370]
pno
f
pc1
pc2
marimba:
pc3
pno

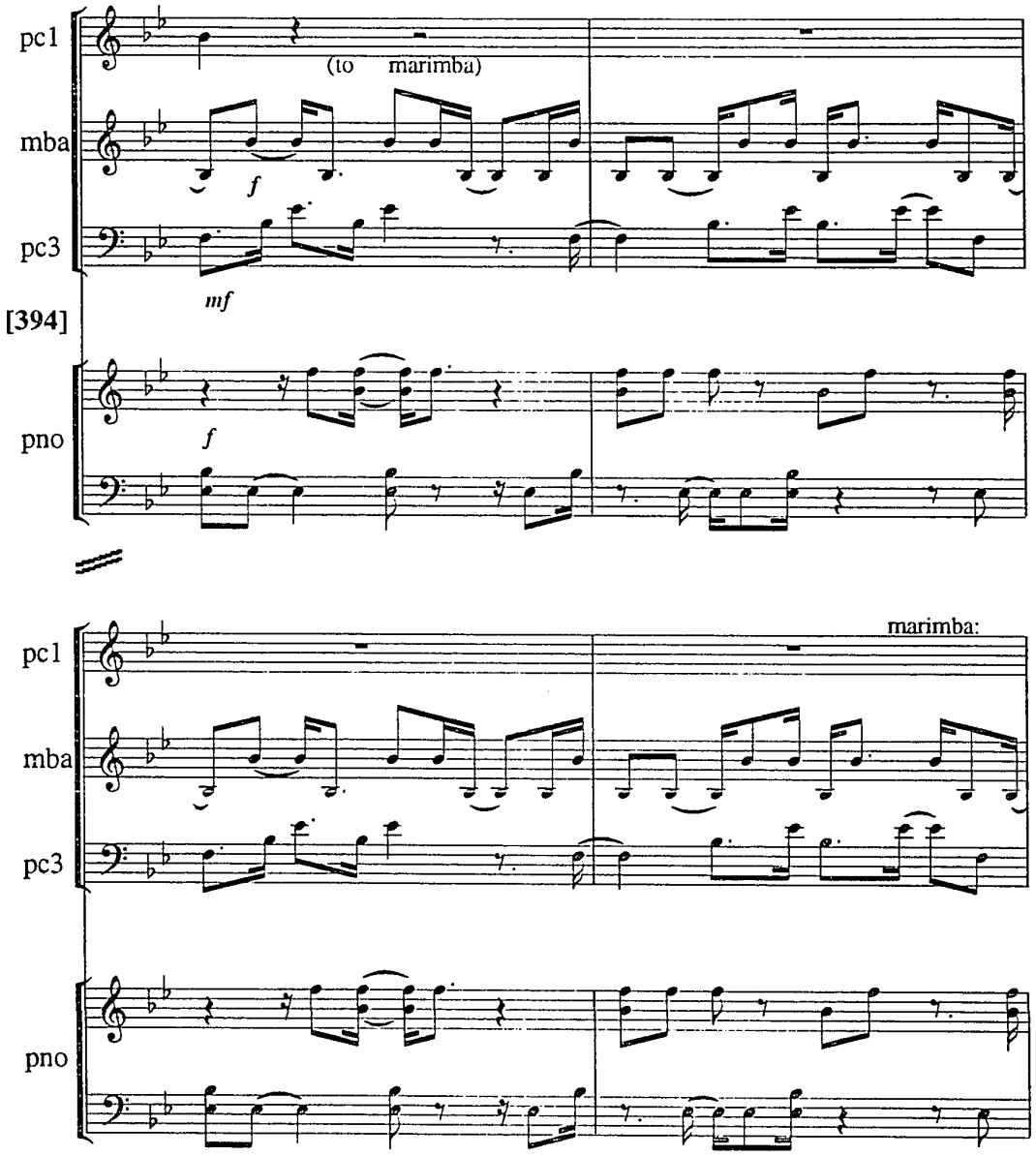

pc1
mba
pc3
mf
f
mf
[374]
pno
f
pc1
mba
pc3
pno

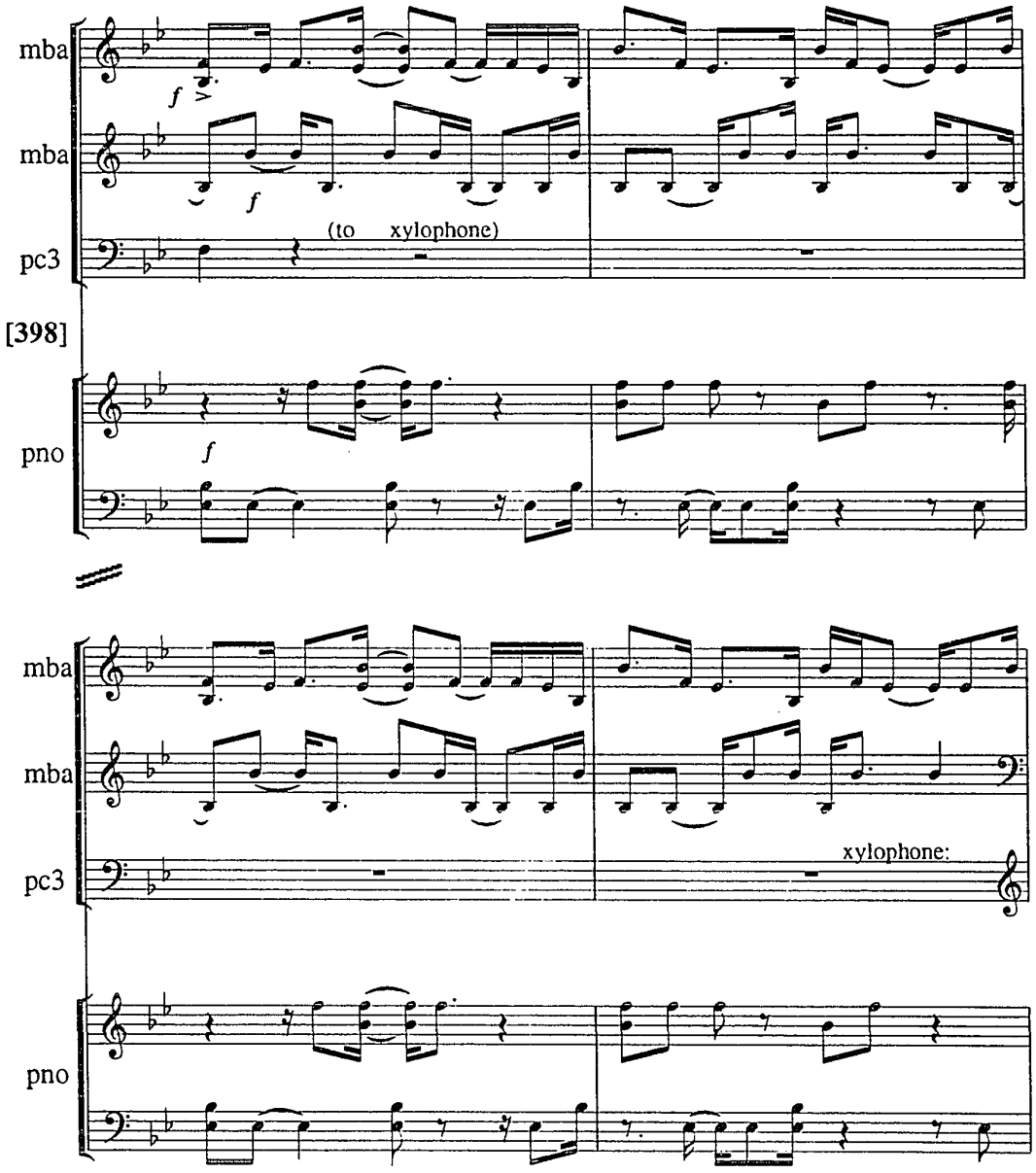

pc1
mba
pc3
pno
mf
f
mf
f
[378]
pc1
mba
pc3
pno

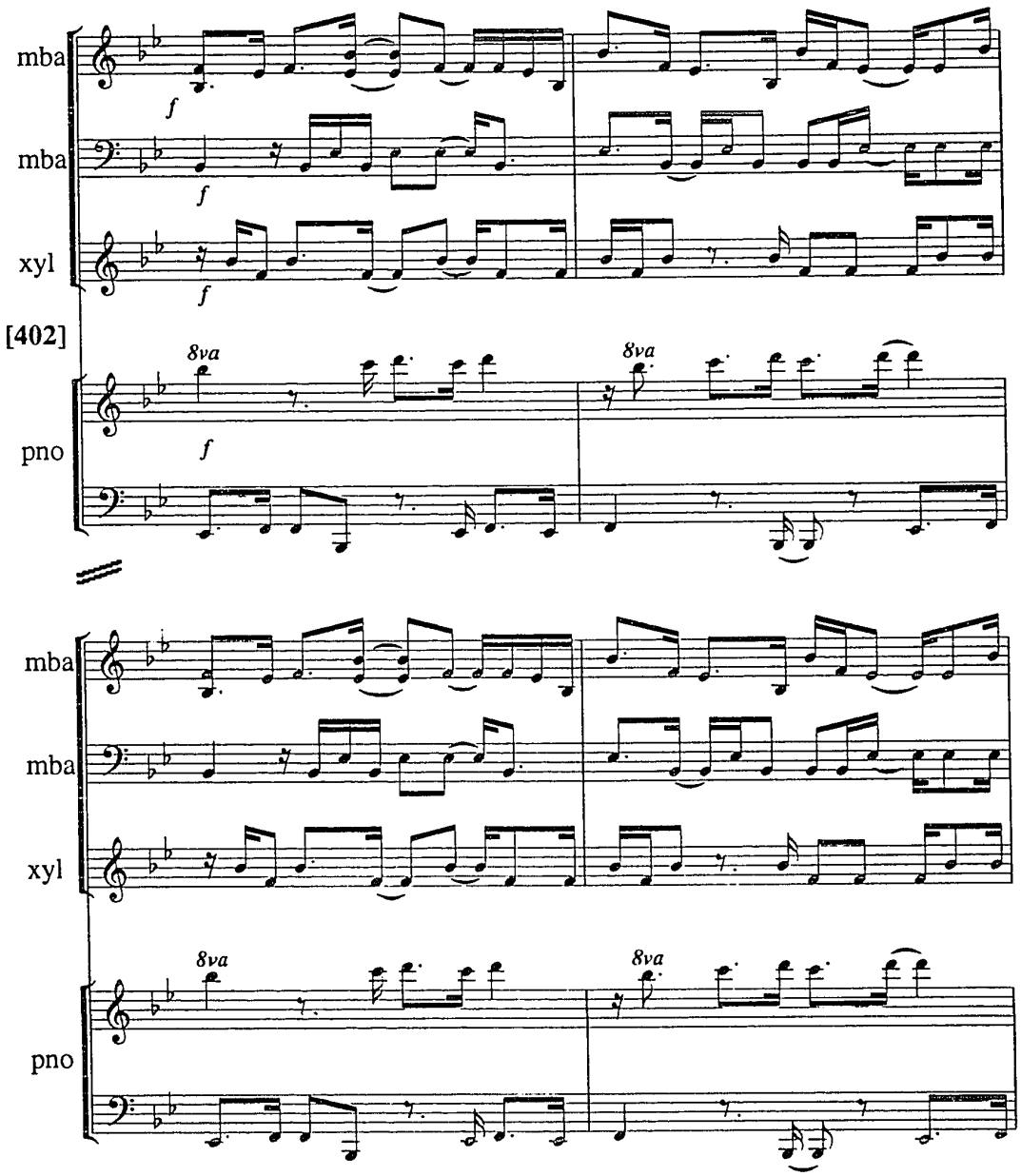

pc1
mba
pc3
pno
mf
f
mf
[382]
f
pc1
mba
pc3
pno

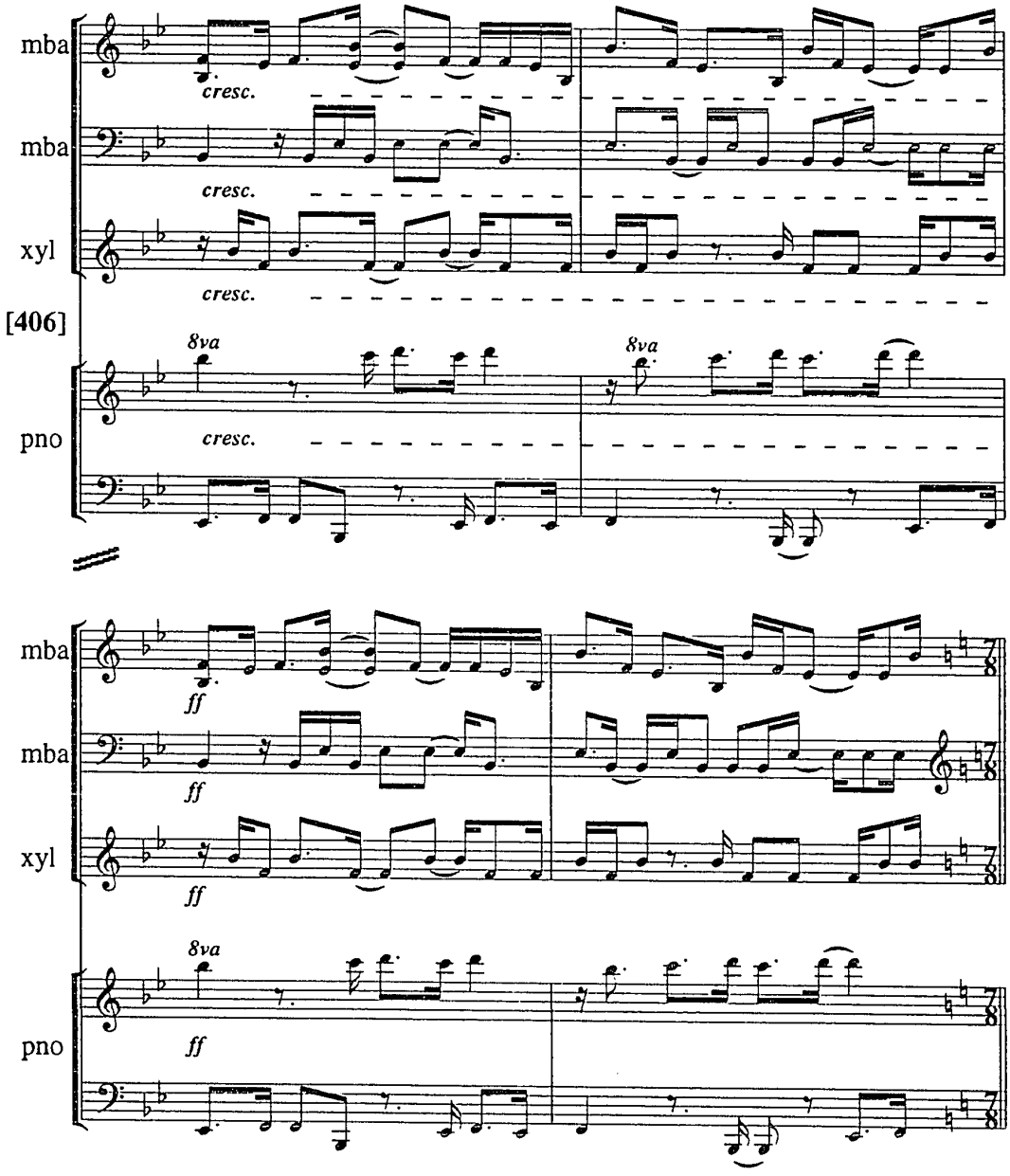

pc1
mba
pc3
mf
f
mf
[386]
pno
f
pc1
mba
pc3
pno

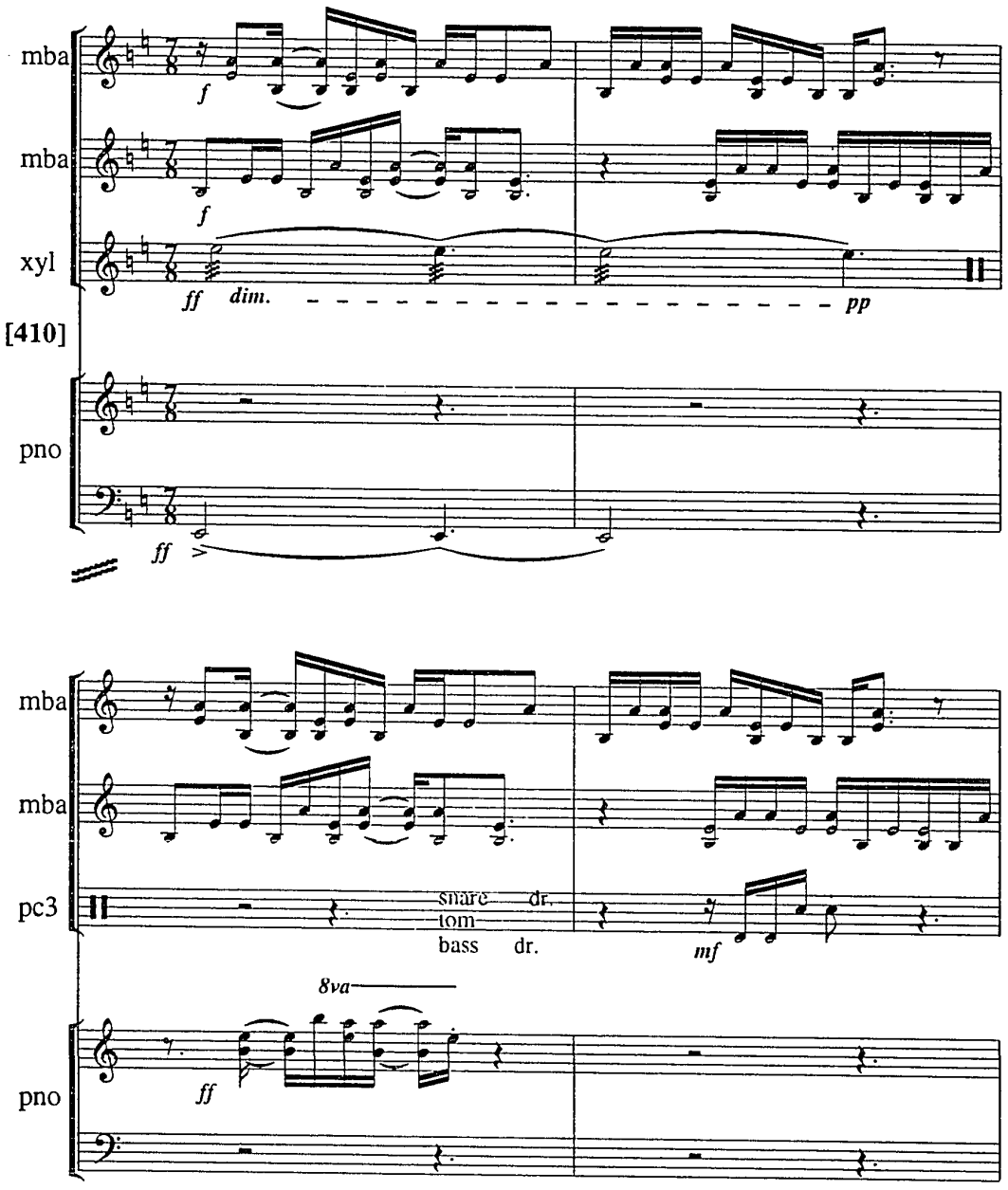

pc1
mba
pc3
mf
f
mf
[390]
pno
f
pc1
mba
pc3
pno

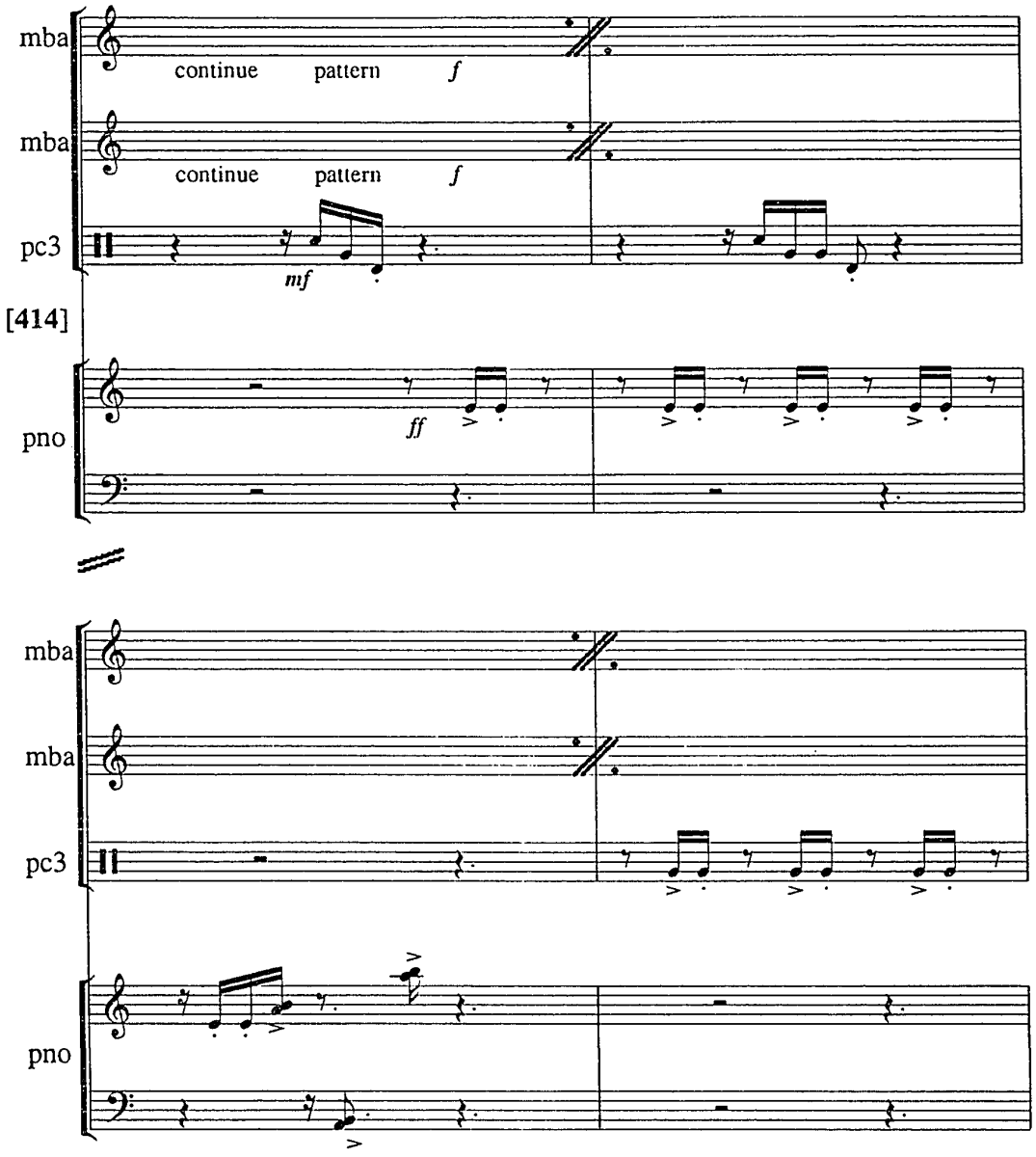

pc1
(to marimba)
mba
f
pc3
mf
[394]
pno
f
marimba:
pc1
mba
pc3
pno

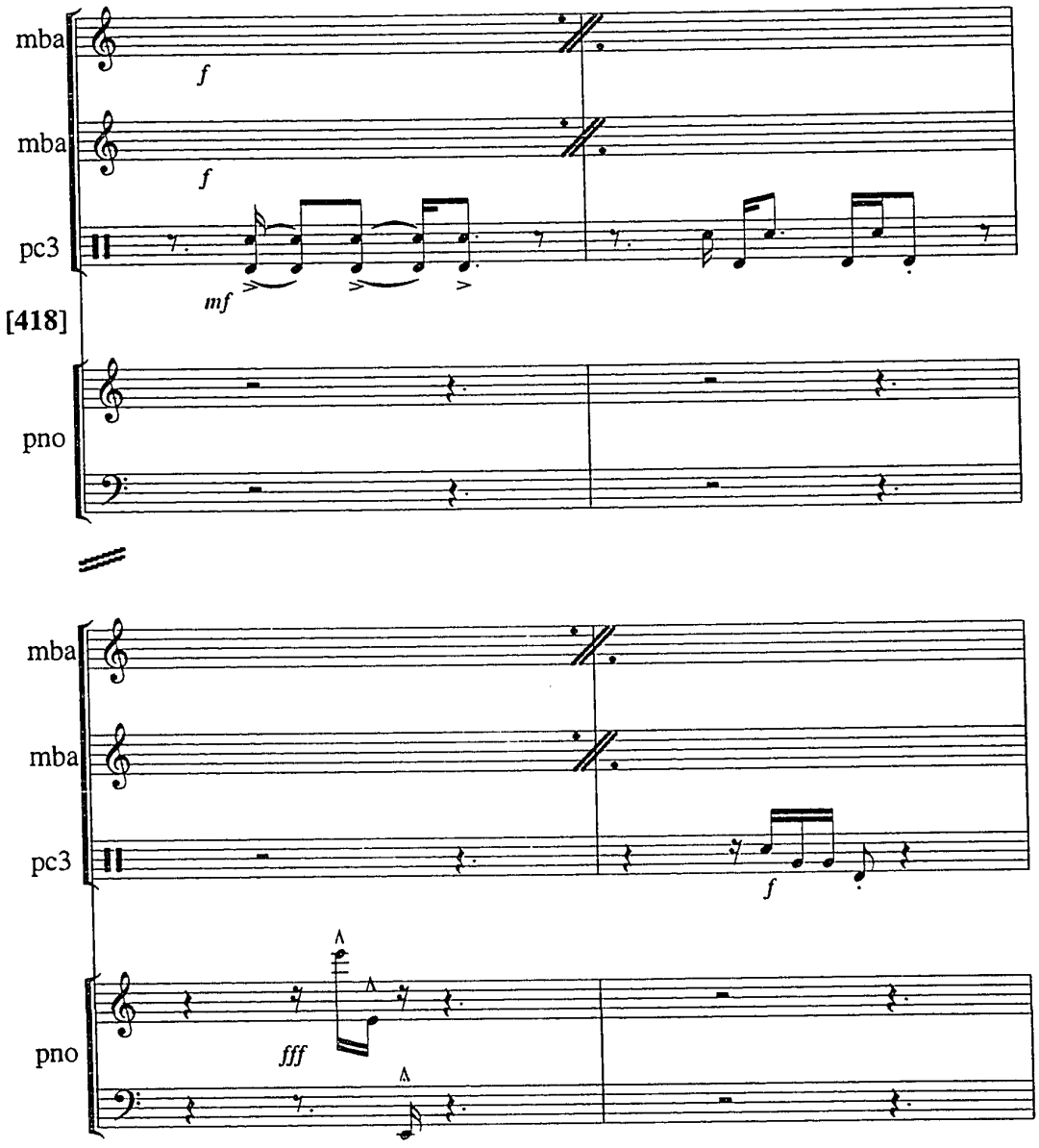

mba
mba
pc3
(to xylophone)
[398]
pno
mba
mba
pc3
xylophone:
pno

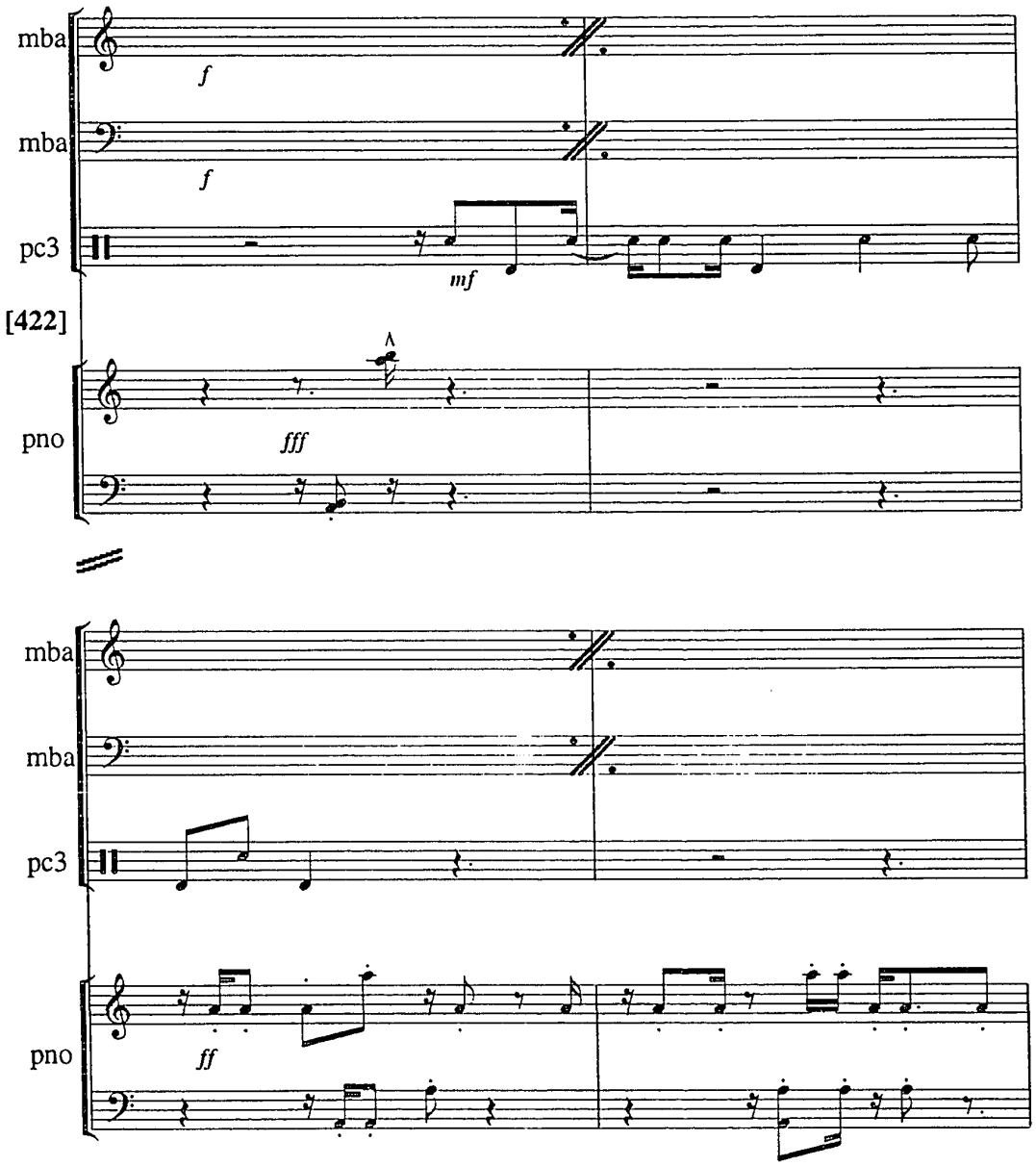

mba
mba
xyl
[402]
pno
8va
8va
mba
mba
xyl
pno
8va
8va

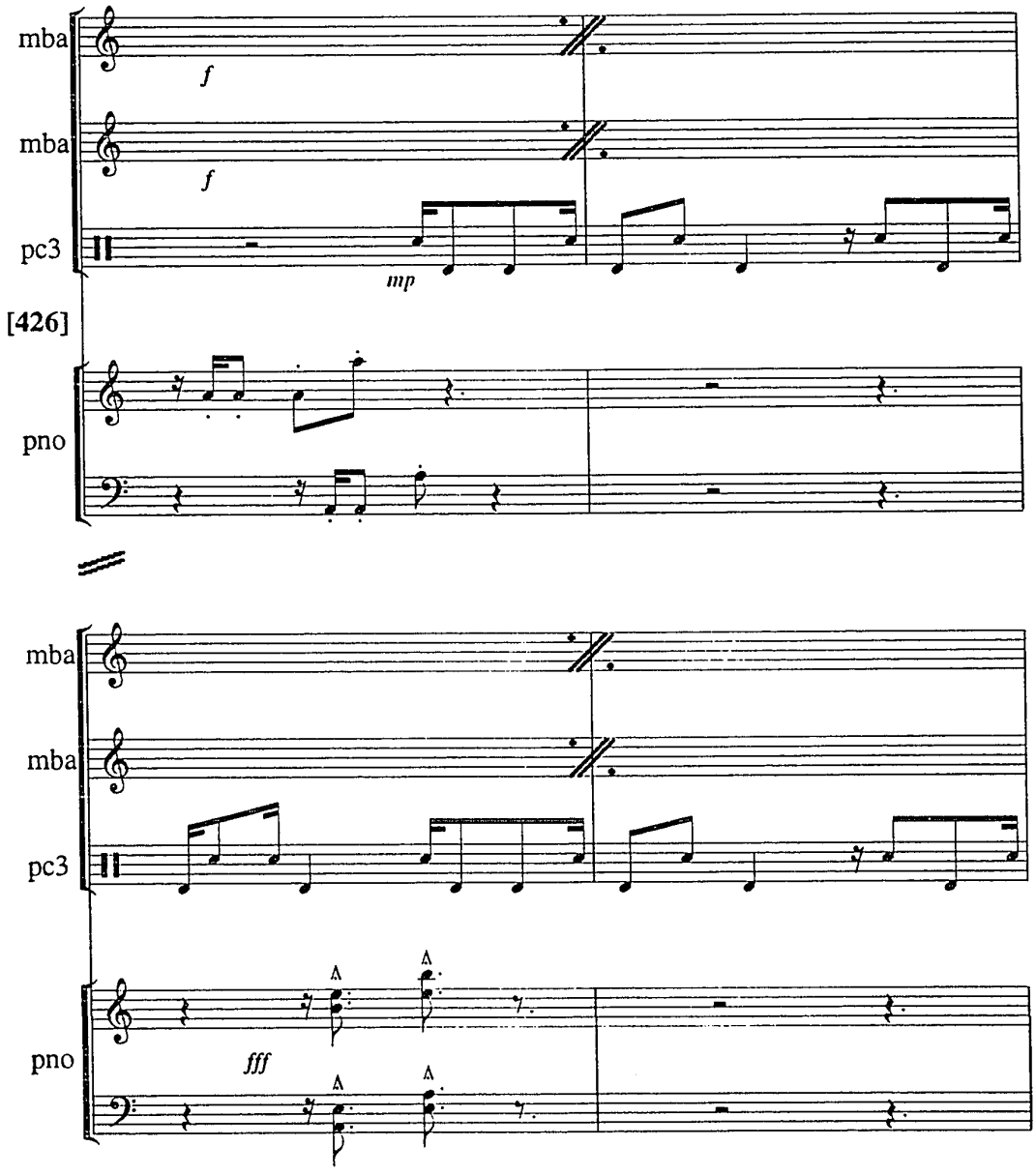

mba
cresc.
mba
cresc.
xyl
cresc.
[406]
8va
8va
pno
cresc.
mba
ff
mba
ff
xyl
ff
8va
pno
ff

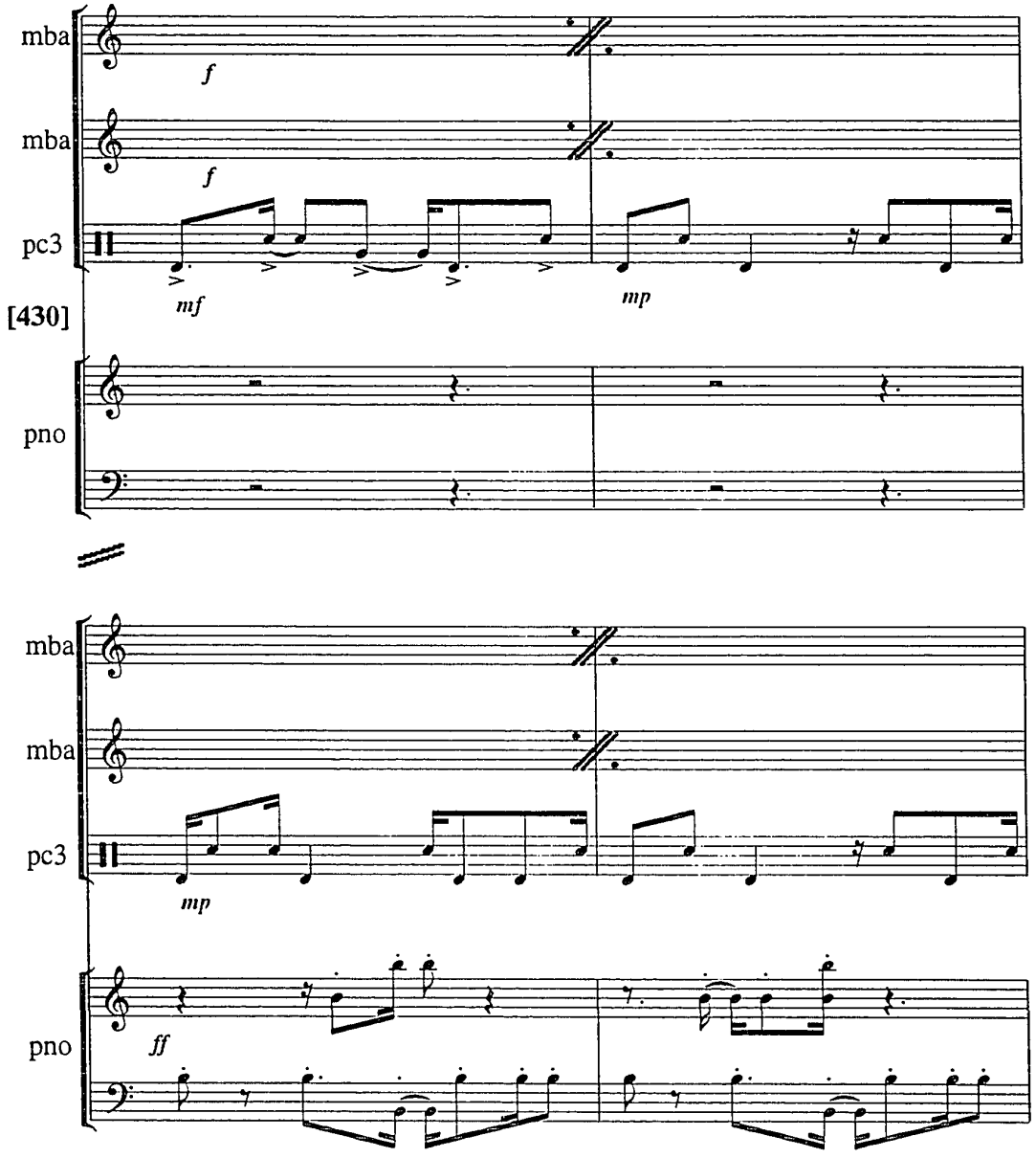

mba
mba
xyl
[410]
pno
mba
mba
pc3
snare dr.
tom
bass dr.
8va
pno

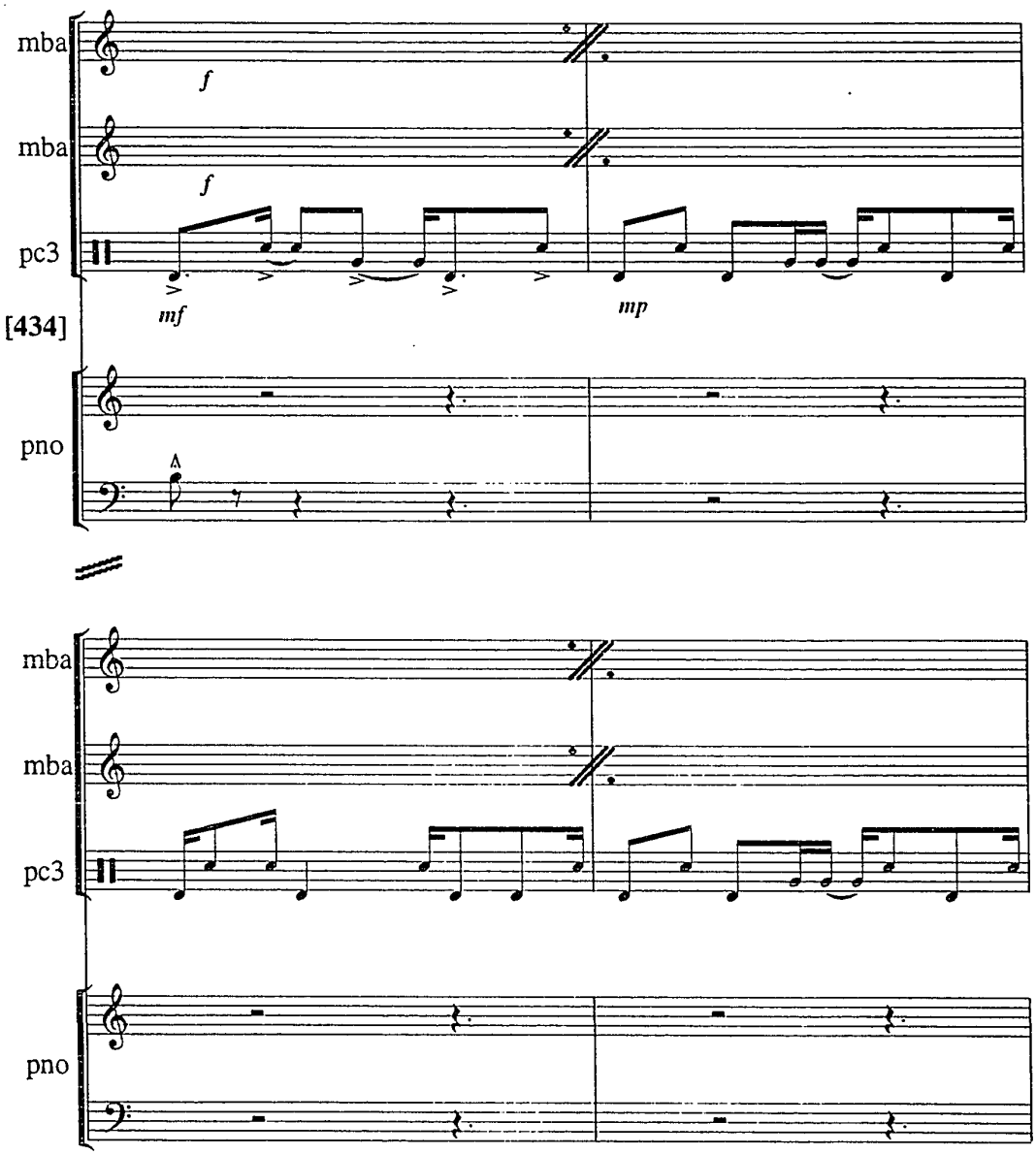

mba
continue pattern f
mba
continue pattern f
pc3
mf
[414]
pno
ff
mba
mba
pc3
pno

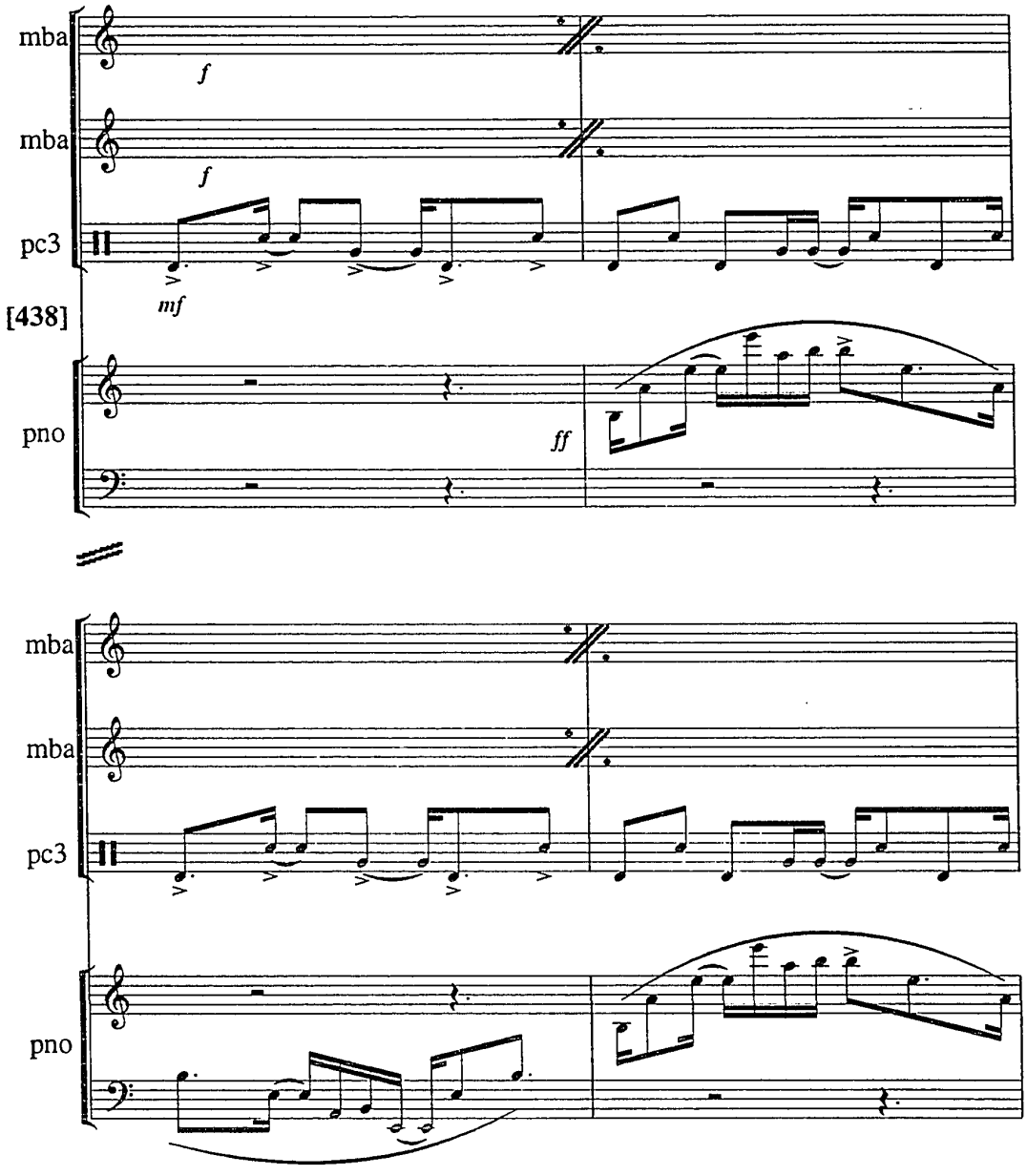

mba
mba
pc3
pno
[418]
f
f
mf
fff
f

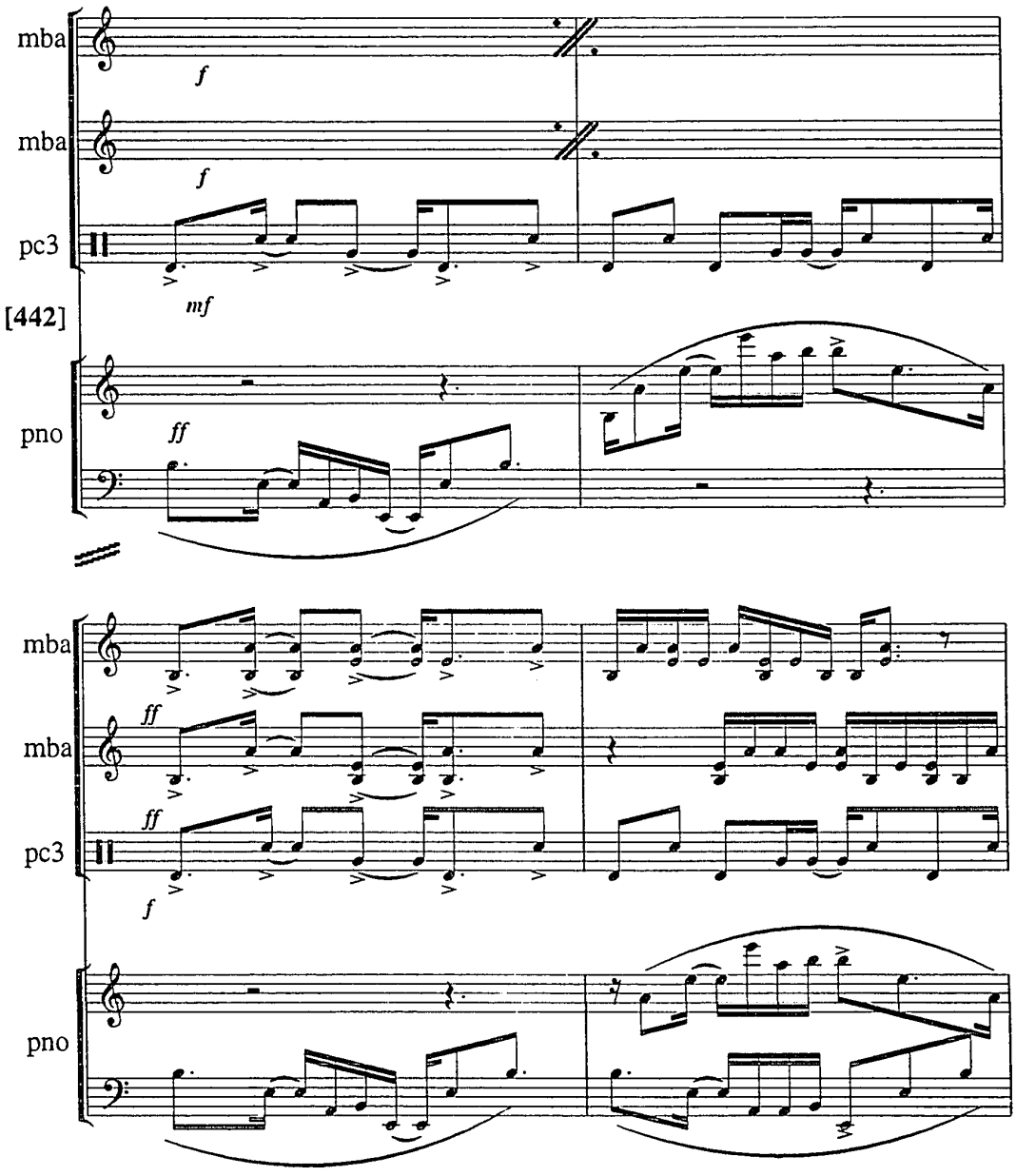

mba
mba
pc3
[422]
pno
mba
mba
pc3
pno
f
f
mf
fff
ff

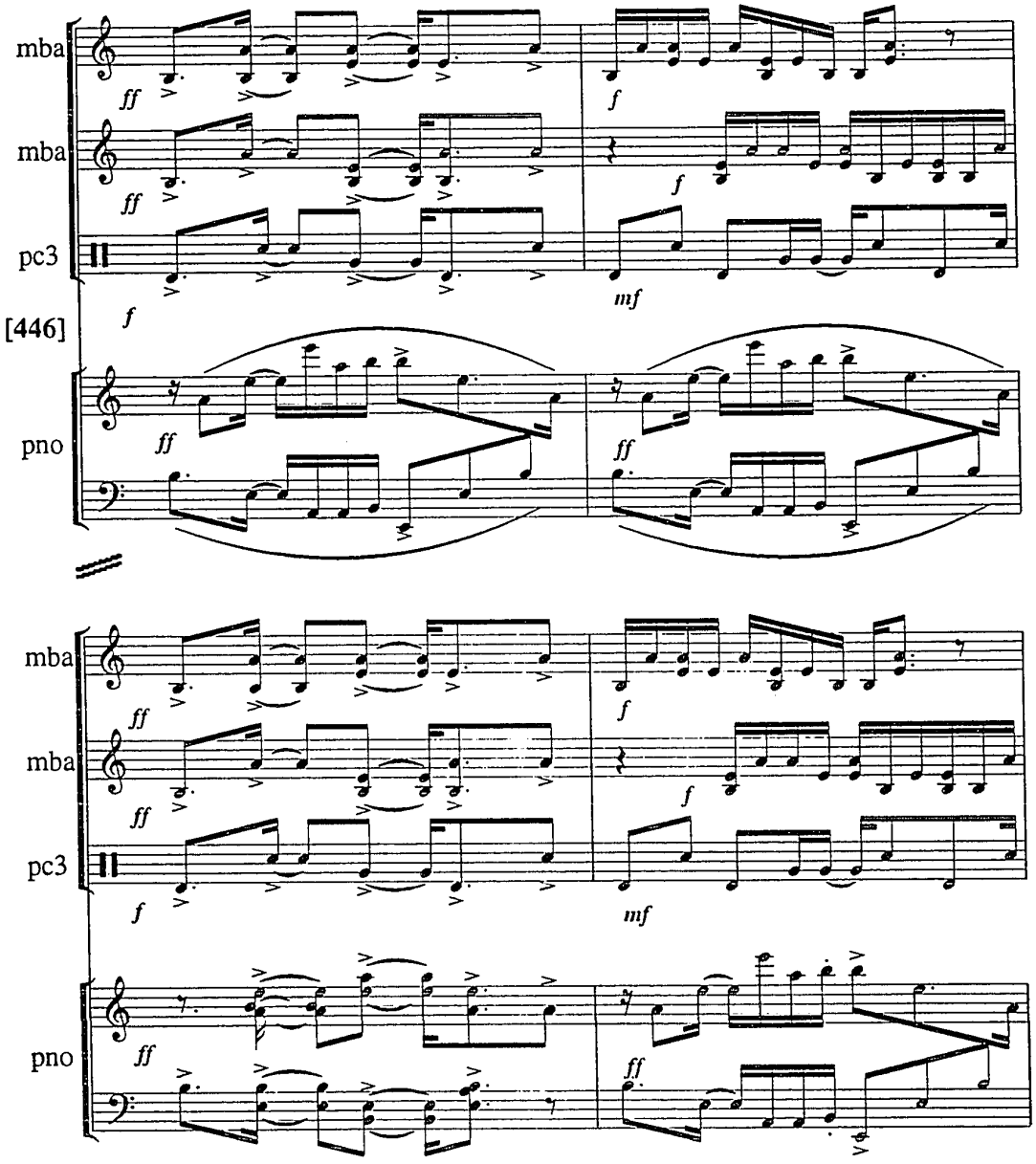

mba
mba
pc3
pno
[426]
mba
mba
pc3
pno
f
f
mp
fff

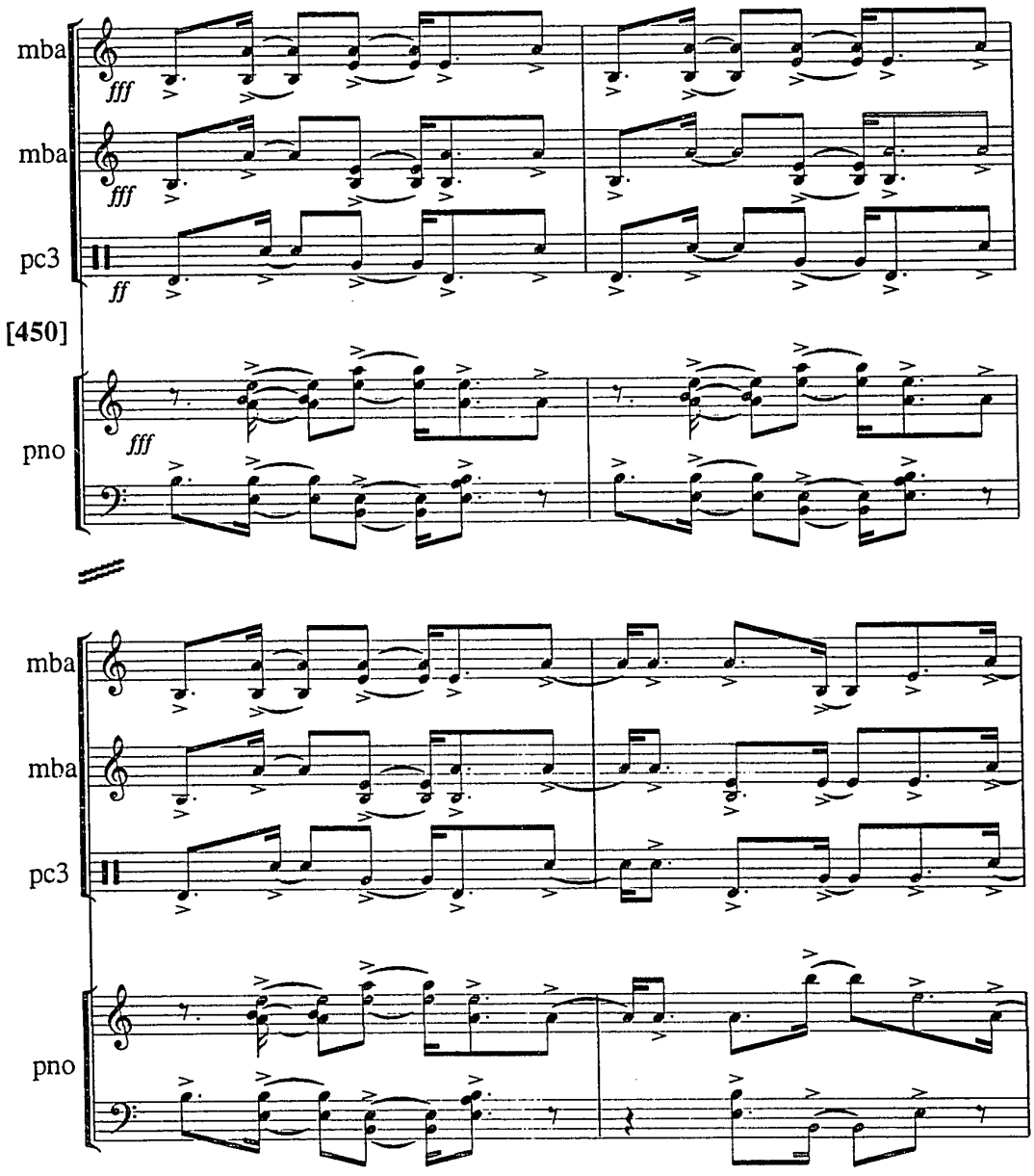

mba
mba
pc3
pno
[430]
f
f
mf
mp
mba
mba
pc3
pno
mp
ff

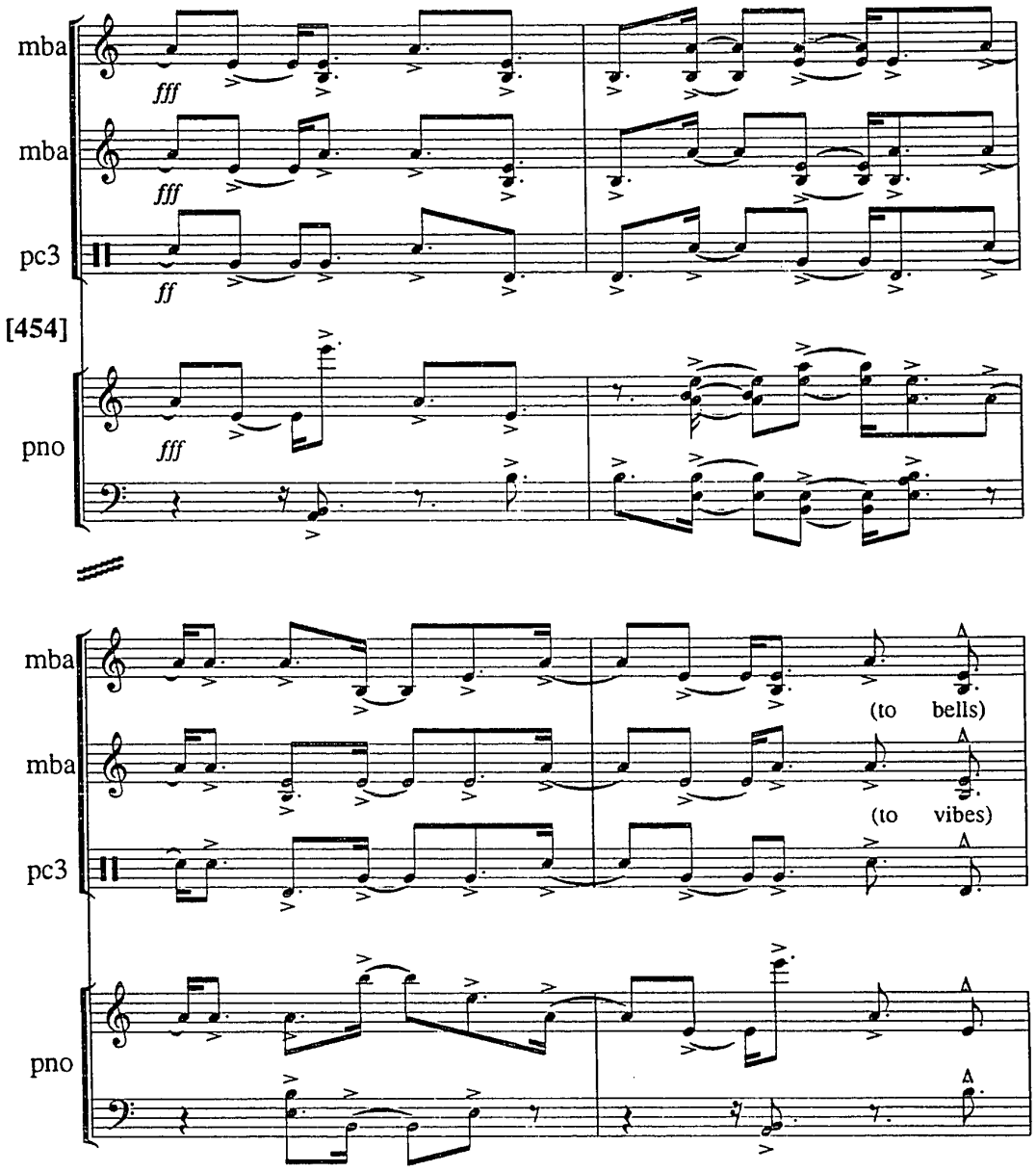

mba
mba
pc3
pno
f
f
mf
mp
[434]
mba
mba
pc3
pno

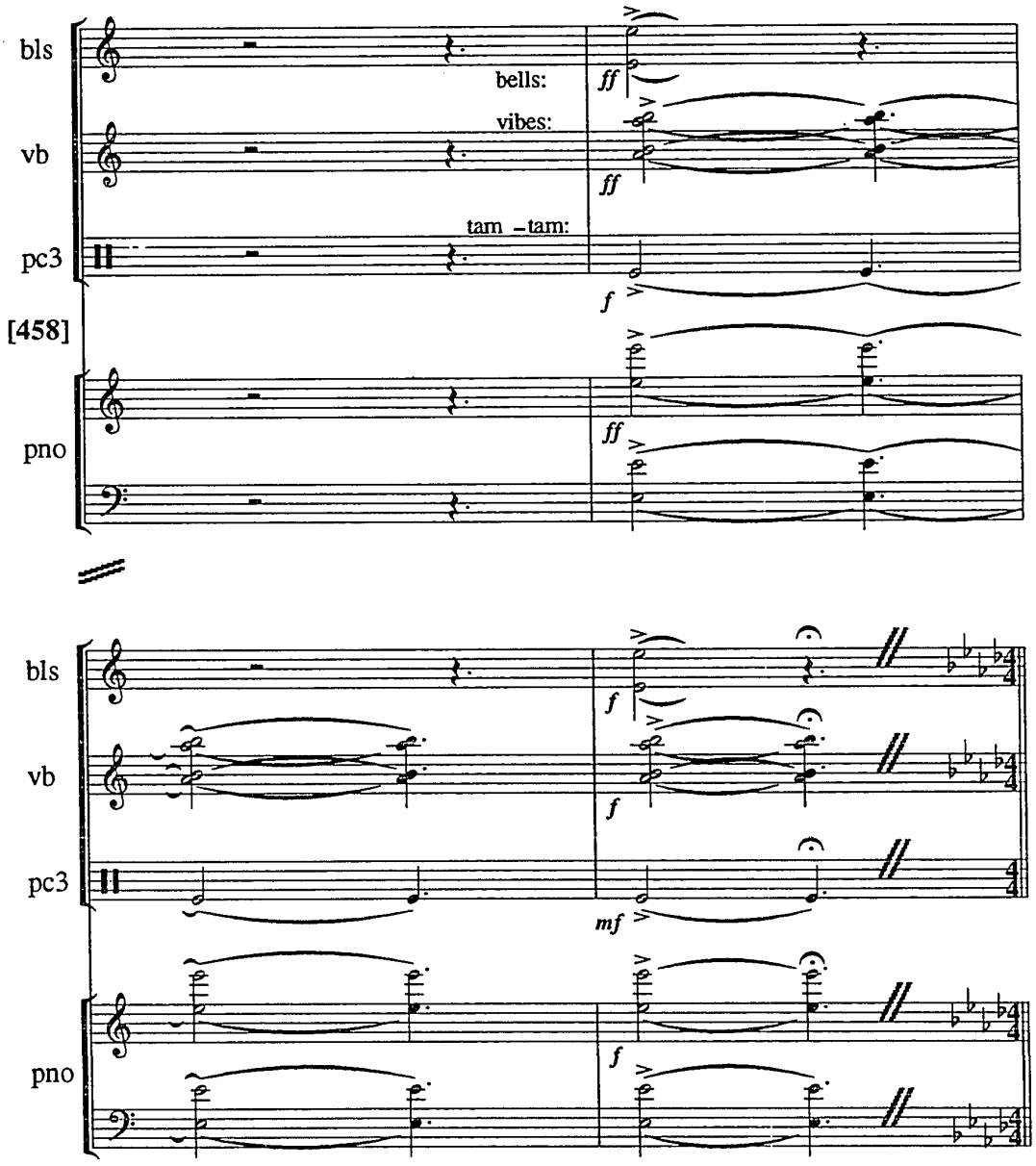

mba
mba
pc3
pno
f
f
mf
[438]
ff
mba
mba
pc3
pno

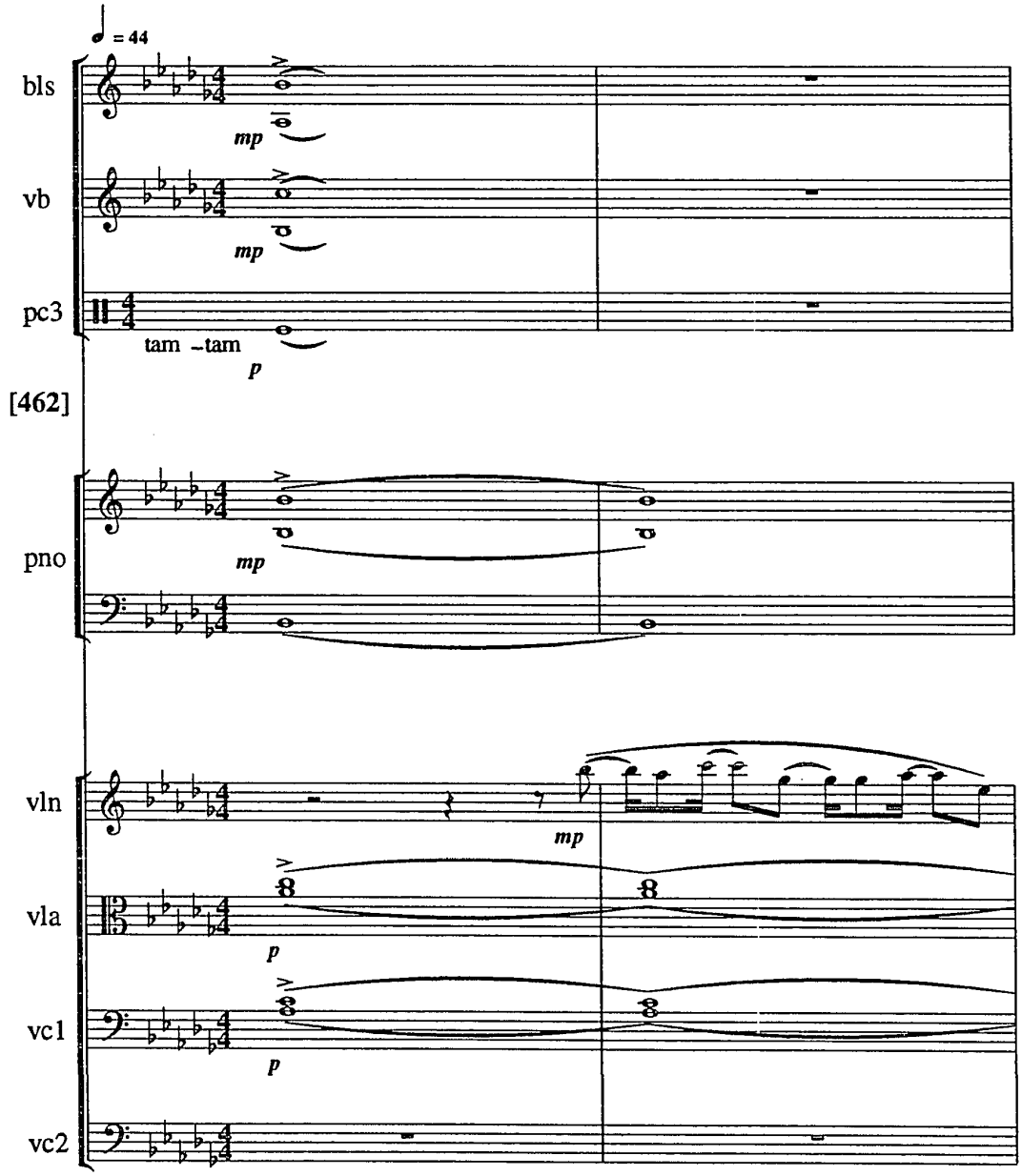

mba
mba
pc3
[442]
pno
mba
mba
pc3
pno

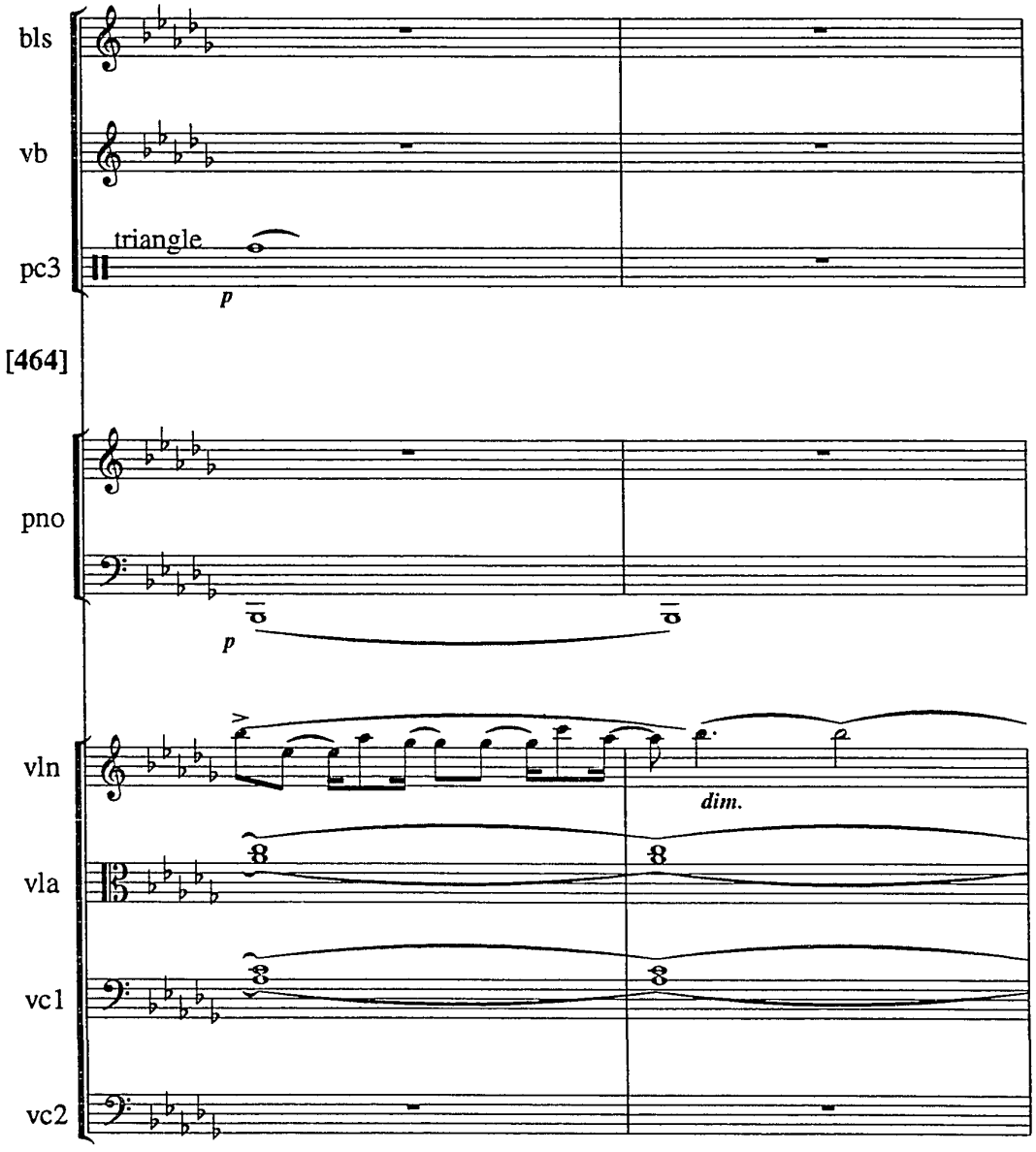

mba
mba
pc3
[446]
pno
mba
mba
pc3
pno

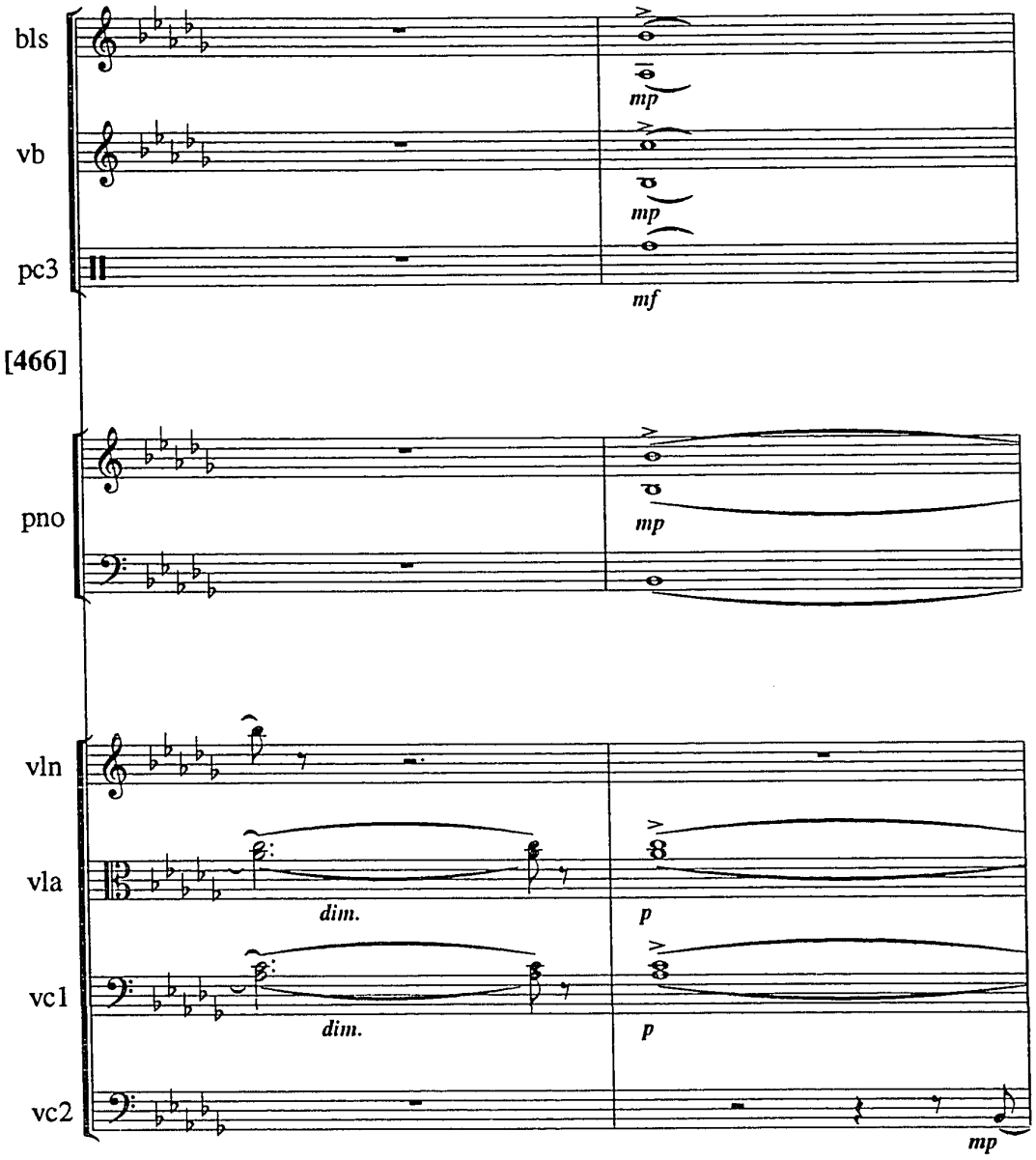

mba
mba
pc3
[450]
pno
mba
mba
pc3
pno

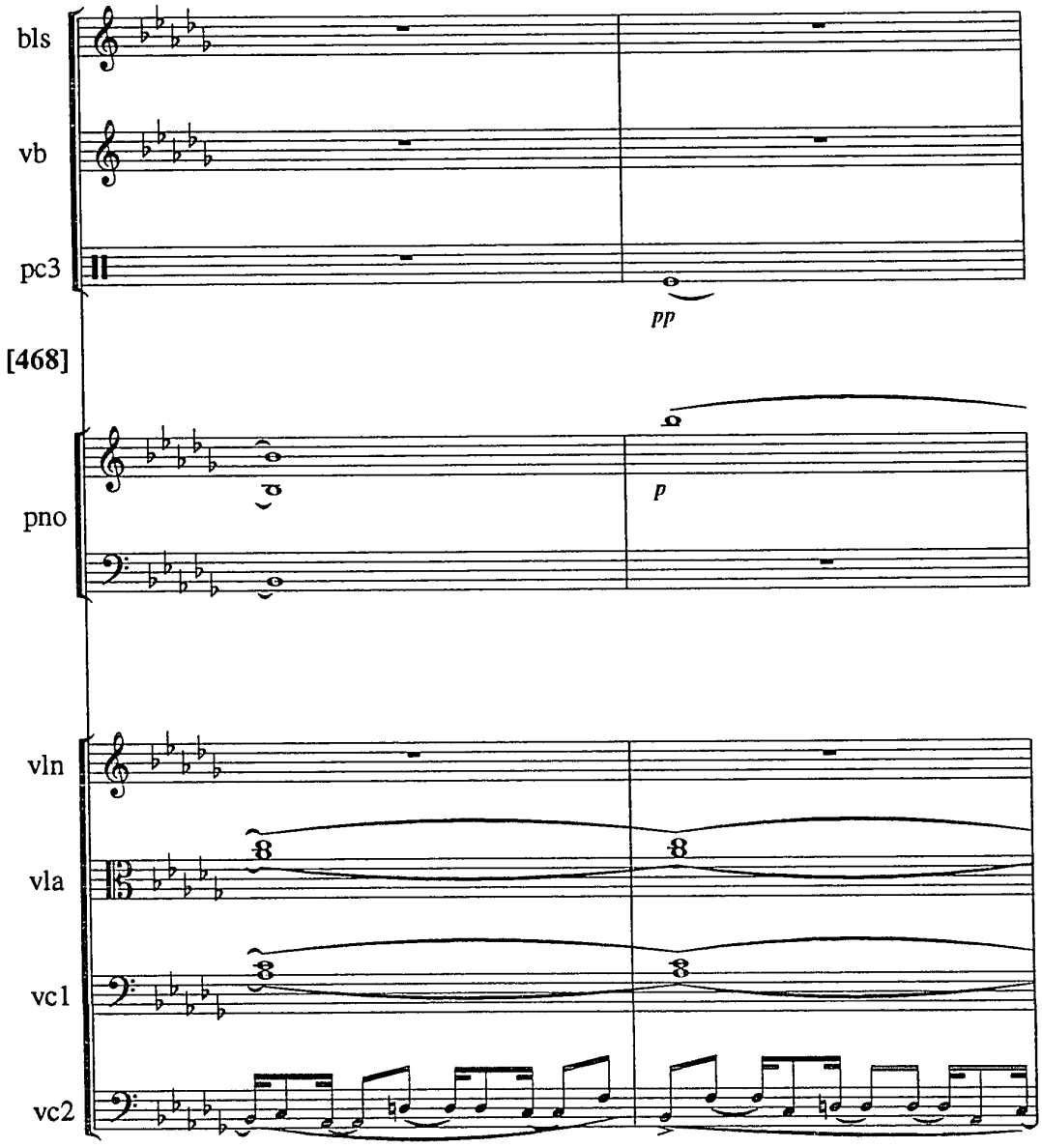

mba
fff
mba
fff
pc3
ff
[454]
pno
fff
mba
(to bells)
mba
(to vibes)
pc3
pno

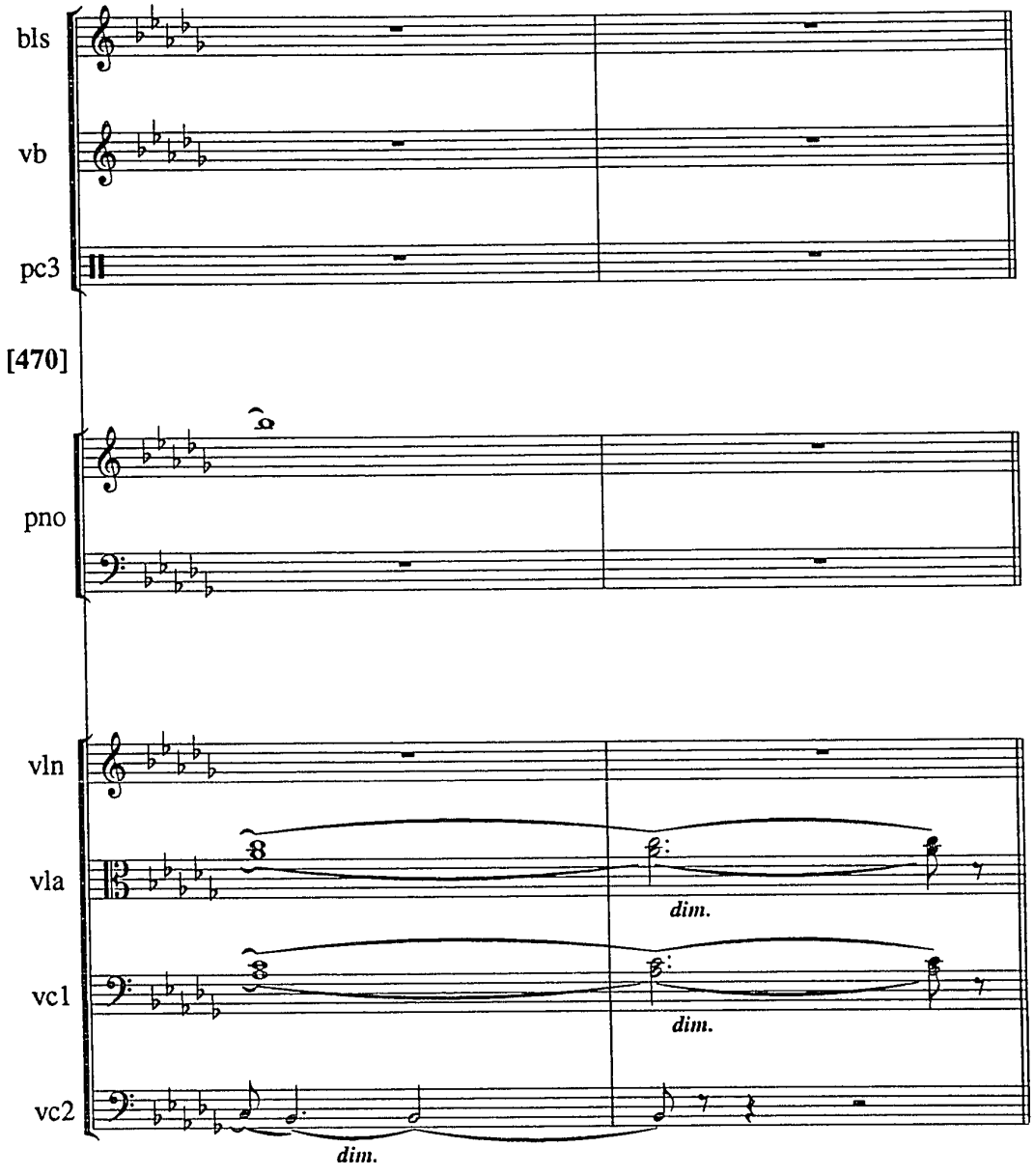

bls
vb
pc3
[458]
pno
bells:
vibes:
tam –tam:
ff
ff
f
ff
f
f
f
mf
f

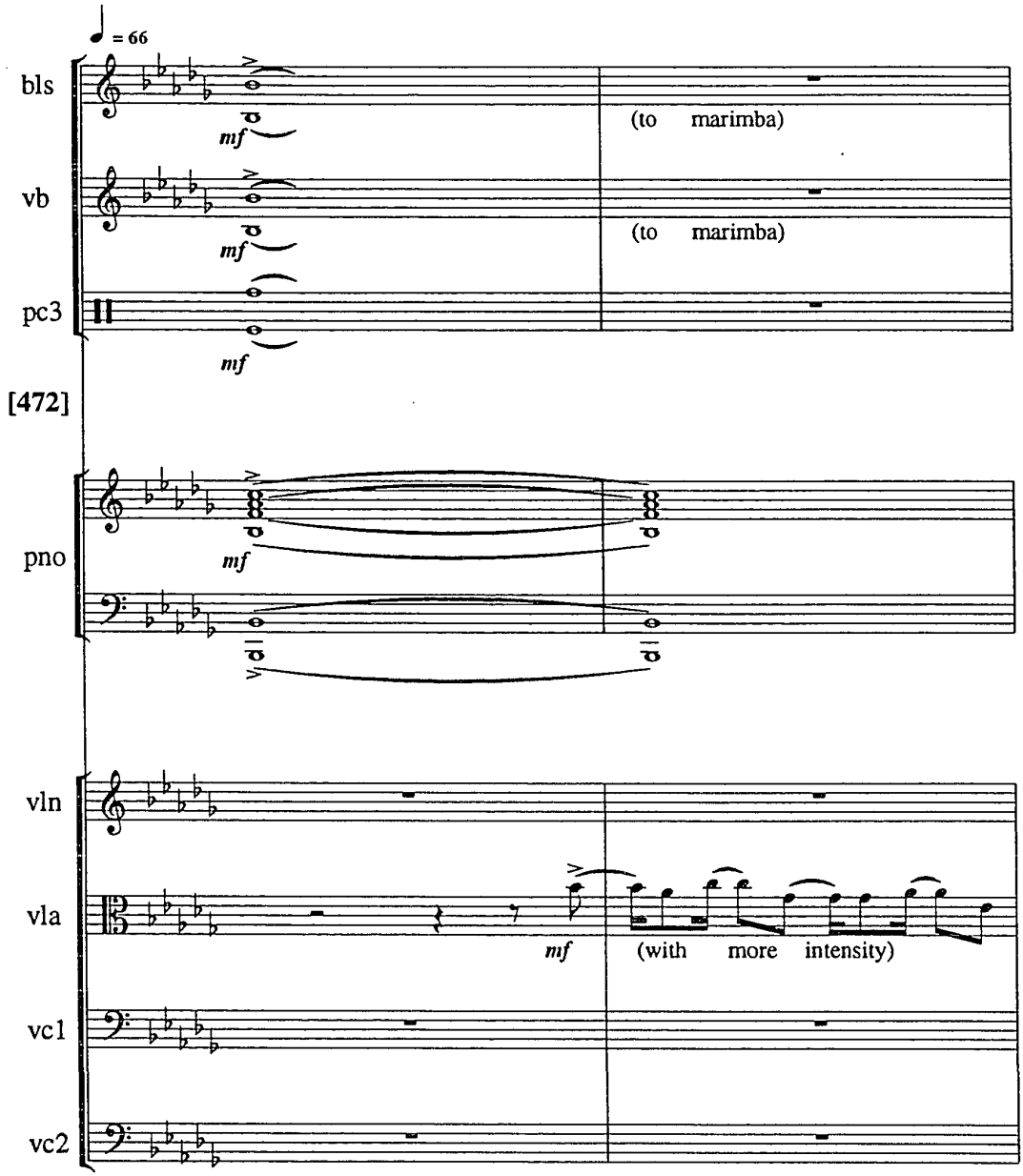

♩ = 44
bls
mp
vb
mp
pc3
tam –tam
p
[462]
pno
mp
vln
mp
vla
p
vc1
p
vc2

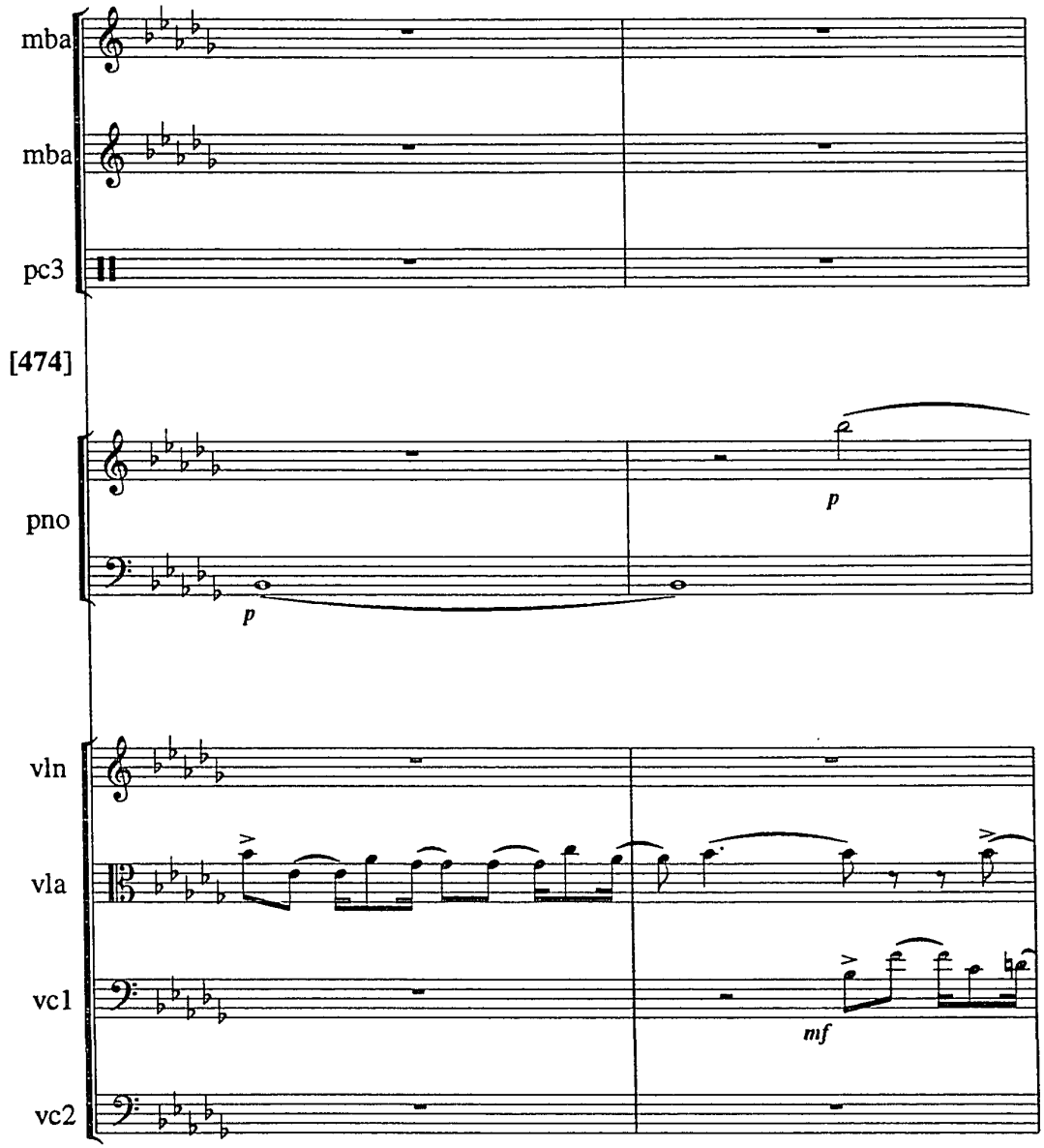

bls
vb
triangle
pc3
p
[464]
pno
p
vln
dim.
vla
vc1
vc2

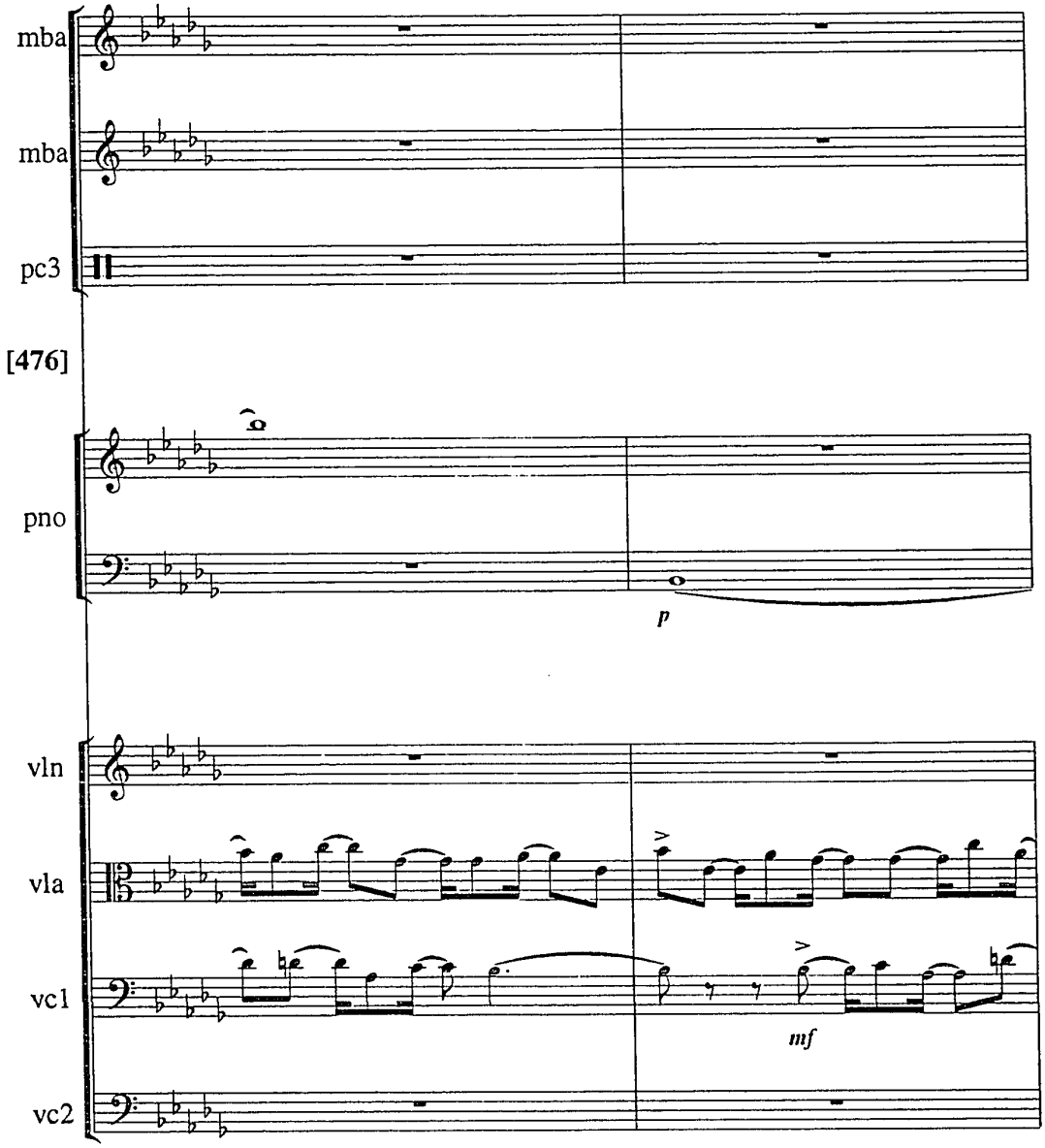

bls
vb
pc3
mp
mp
mf
[466]
pno
mp
vln
vla
vc1
vc2
dim.
dim.
p
p
mp

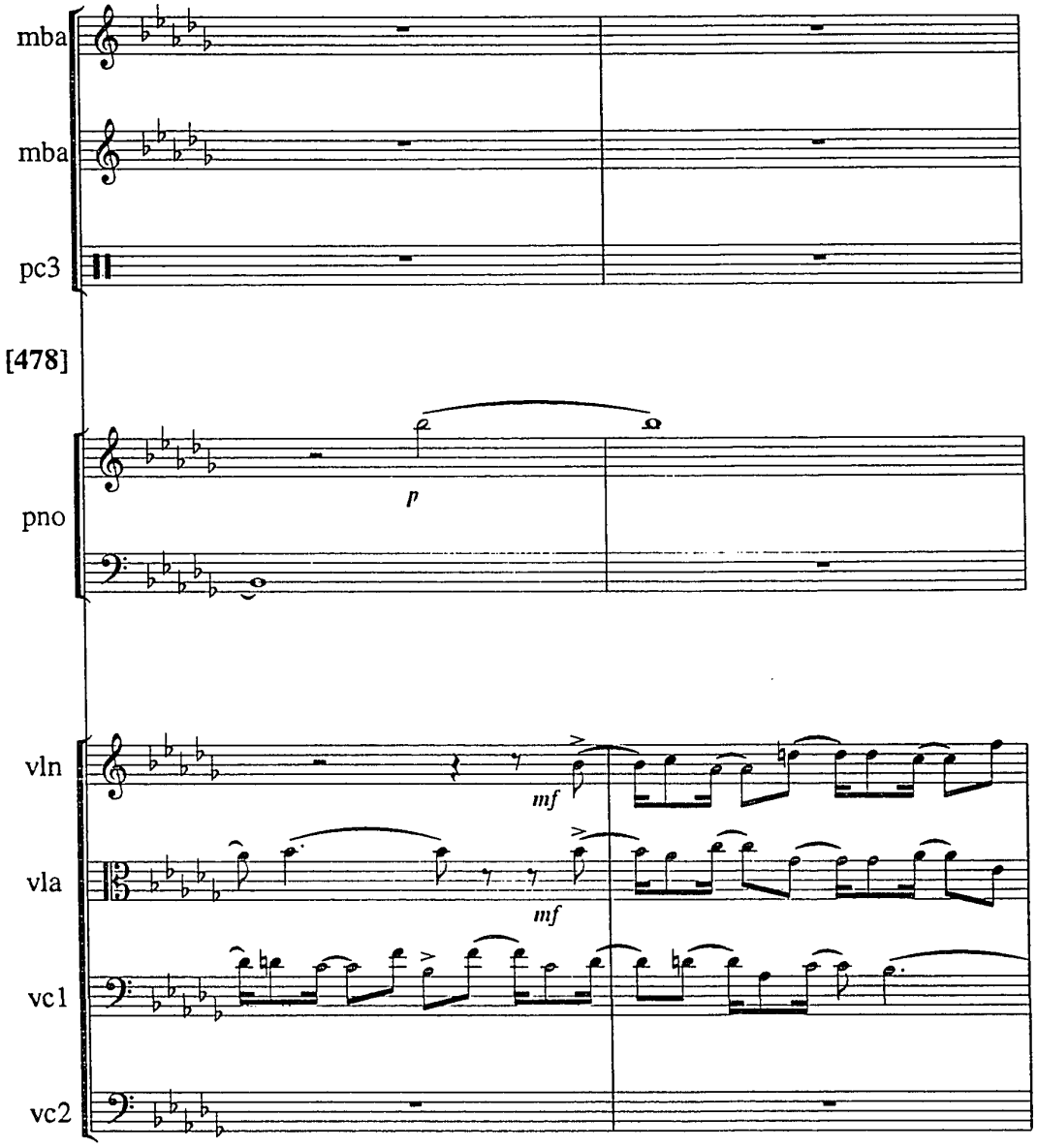

bls
vb
pc3
pp
[468]
pno
p
vln
vla
vc1
vc2

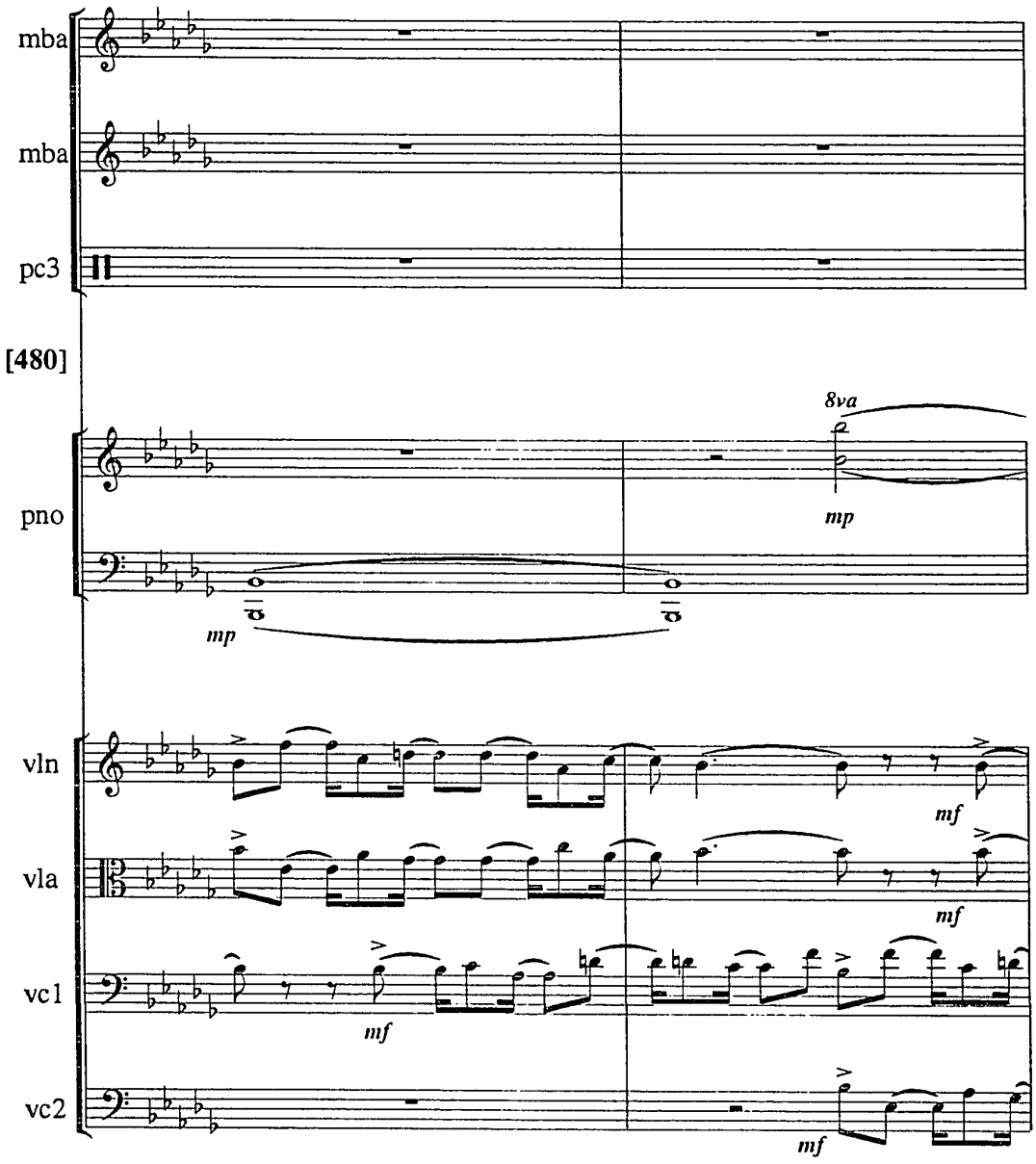

bls
vb
pc3
[470]
pno
vln
vla
dim.
vc1
dim.
vc2
dim.

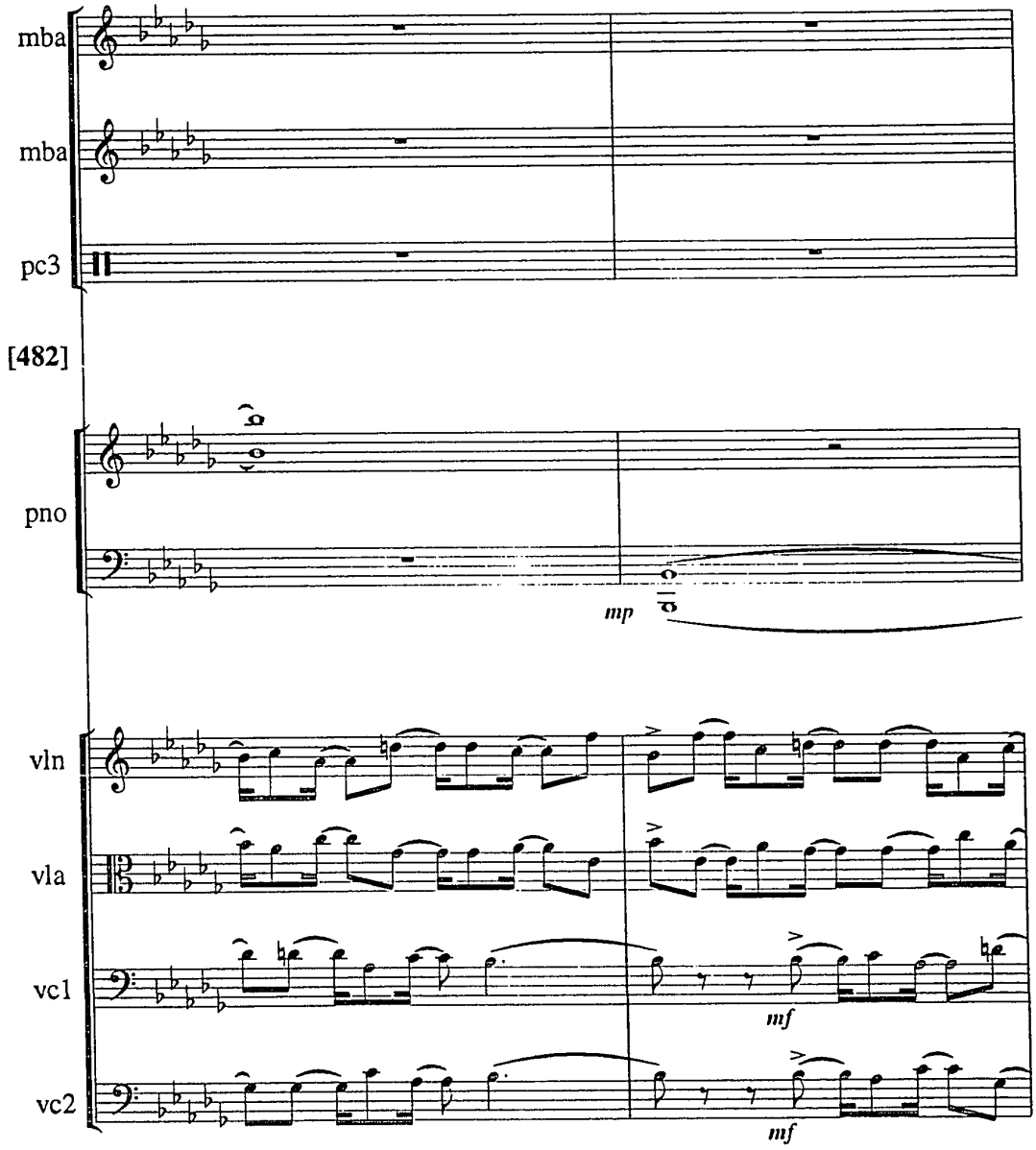

♩ = 66
bls
mf
(to marimba)
vb
mf
(to marimba)
pc3
mf
[472]
pno
mf
vln
vla
mf
(with more intensity)
vc1
vc2

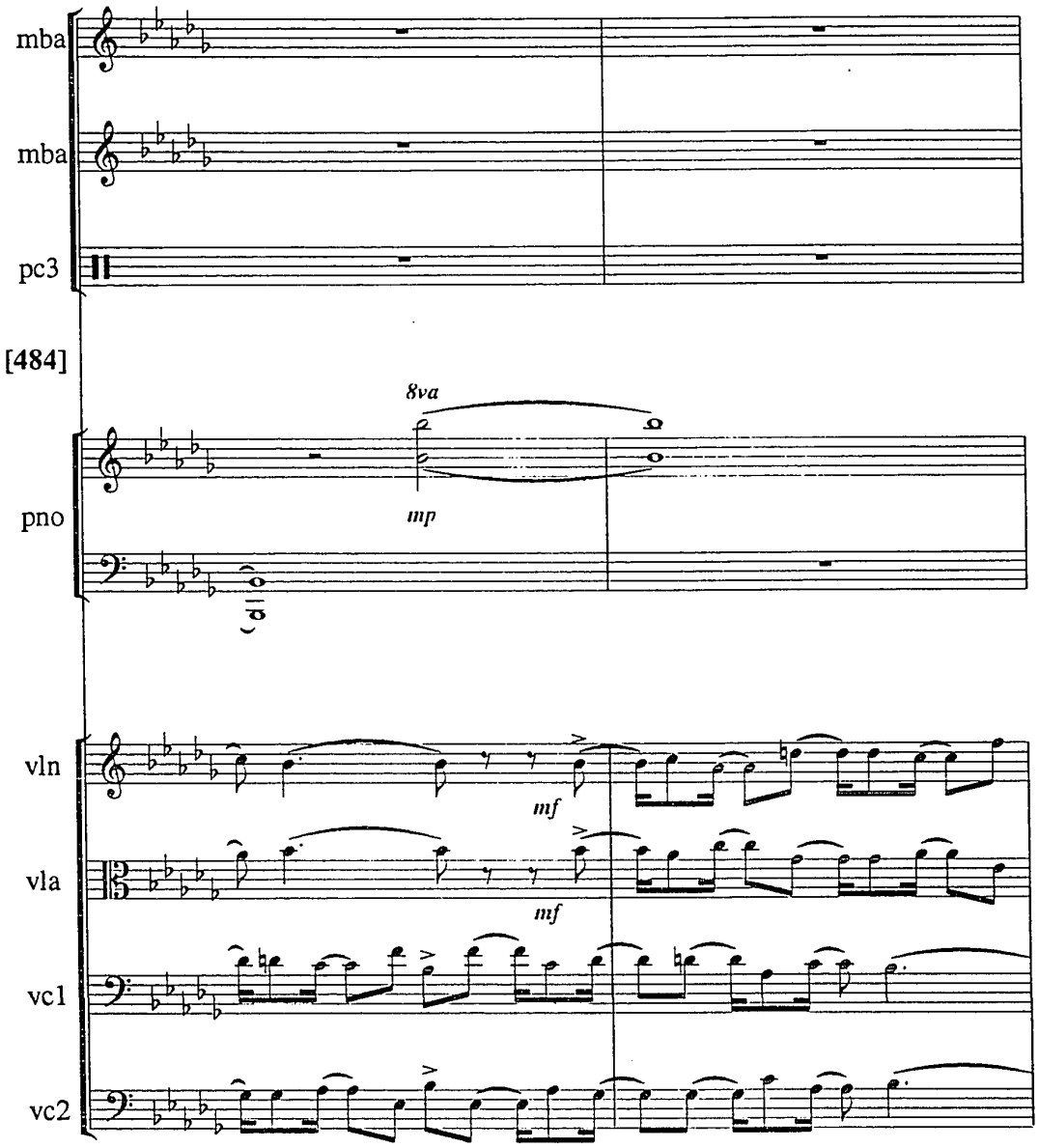

mba
mba
pc3
[474]
pno
p
p
vln
vla
vc1
mf
vc2

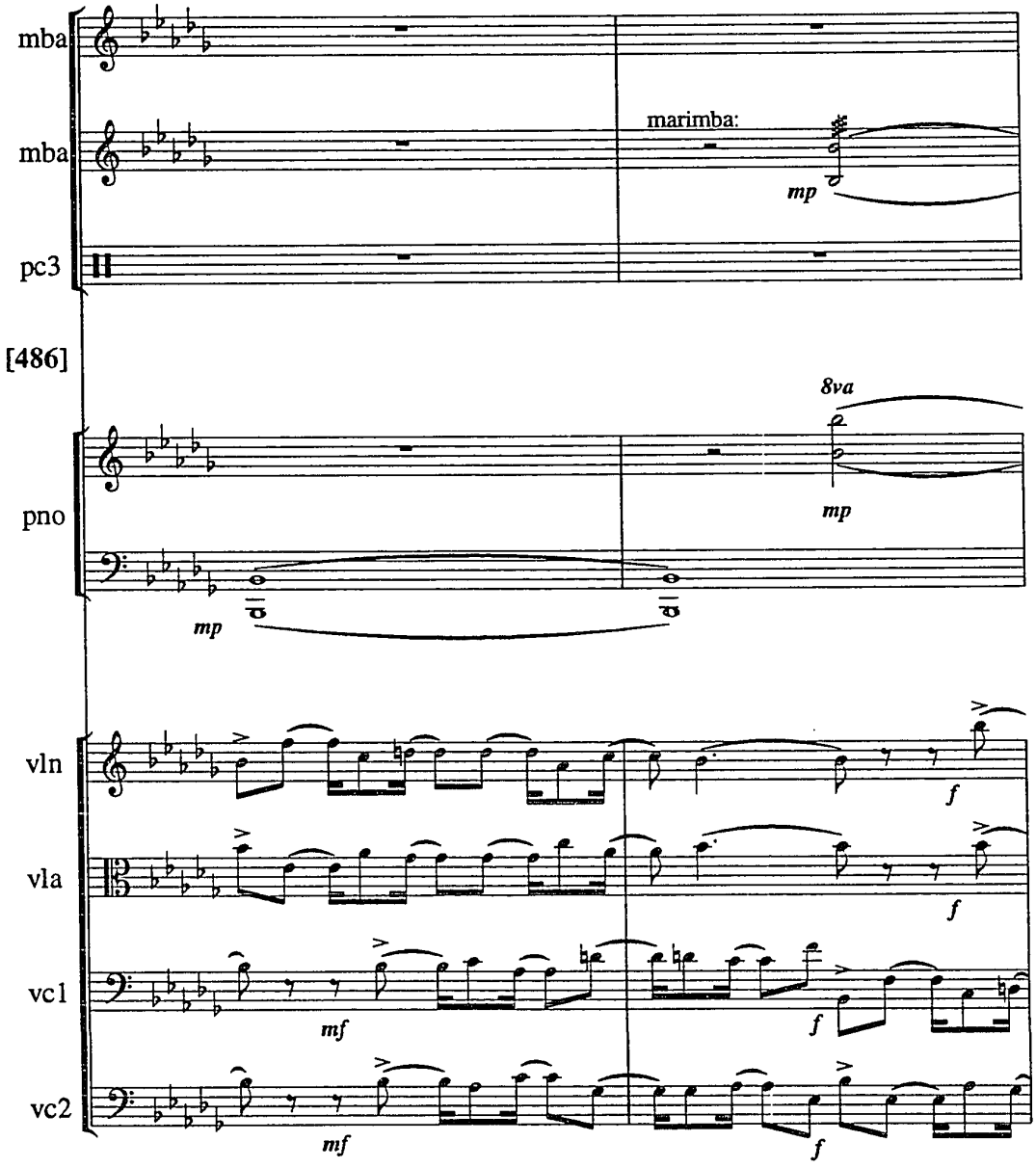

mba
mba
pc3
[476]
pno
p
vln
vla
vc1
mf
vc2

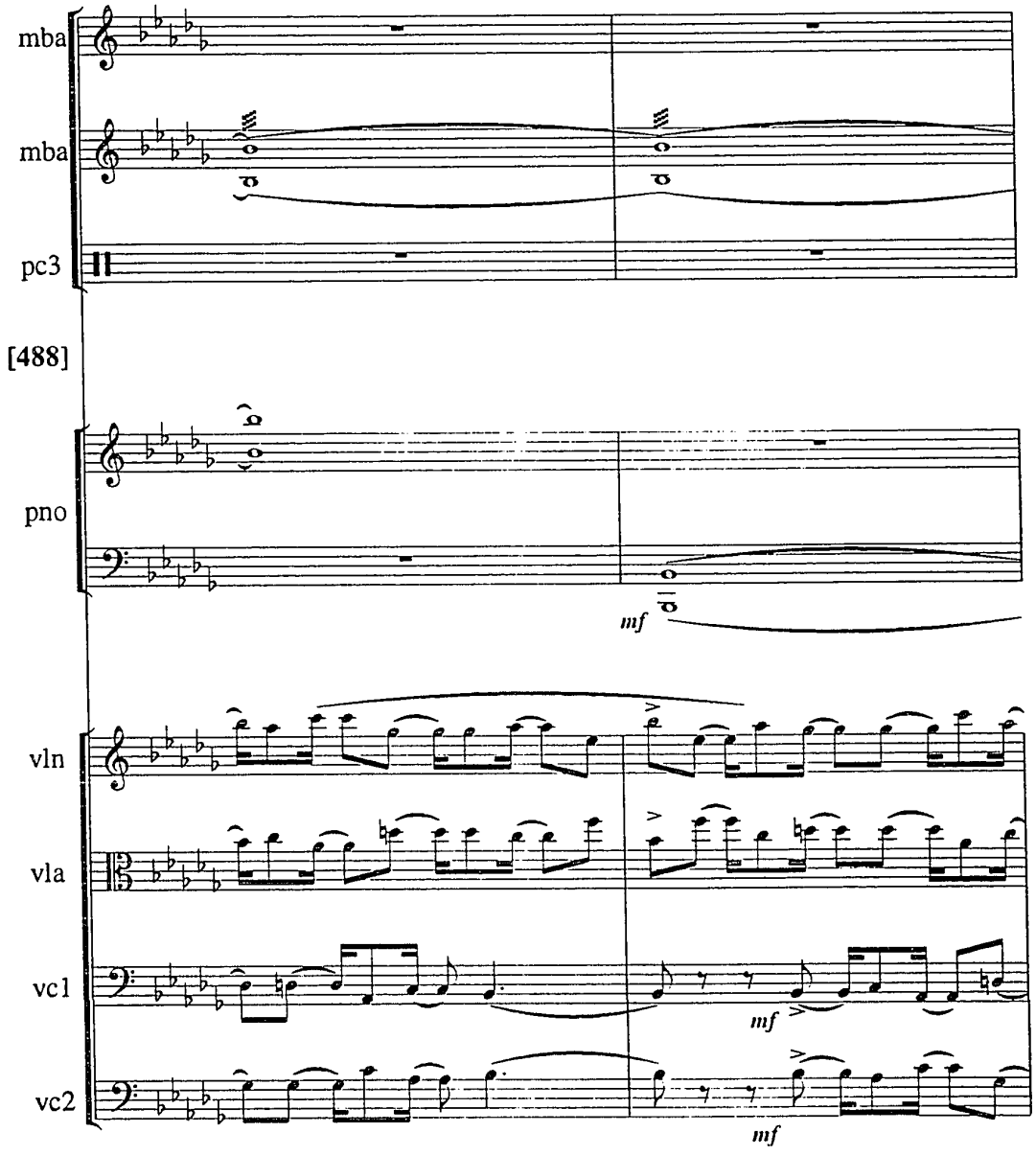

mba
mba
pc3
[478]
pno
p
vln
mf
vla
mf
vc1
vc2

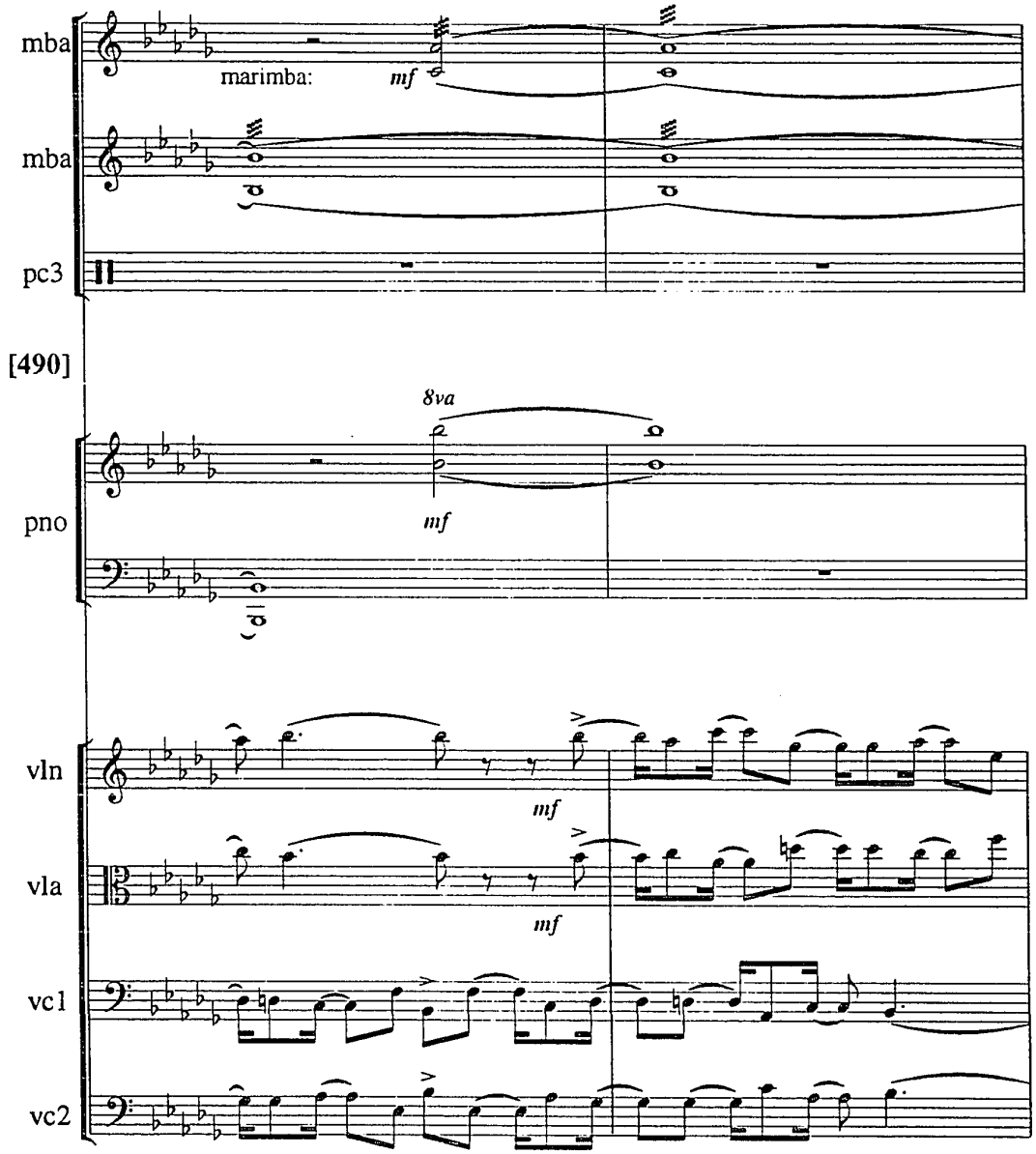

mba
mba
pc3
[480]
8va
mp
pno
mp
vln
mf
vla
mf
vc1
mf
vc2
mf

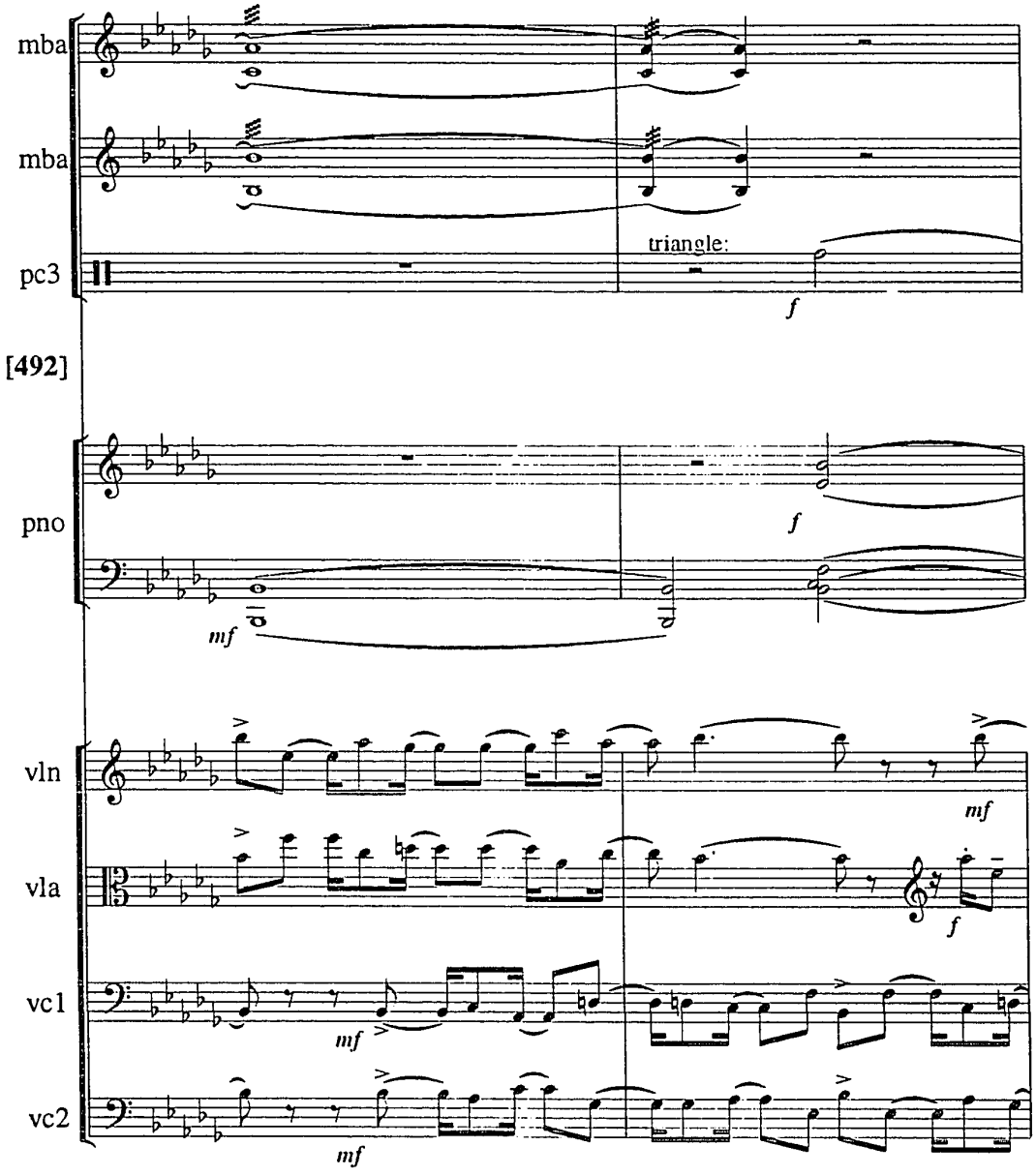

mba
mba
pc3
[482]
pno
mp
vln
vla
vc1
mf
vc2
mf

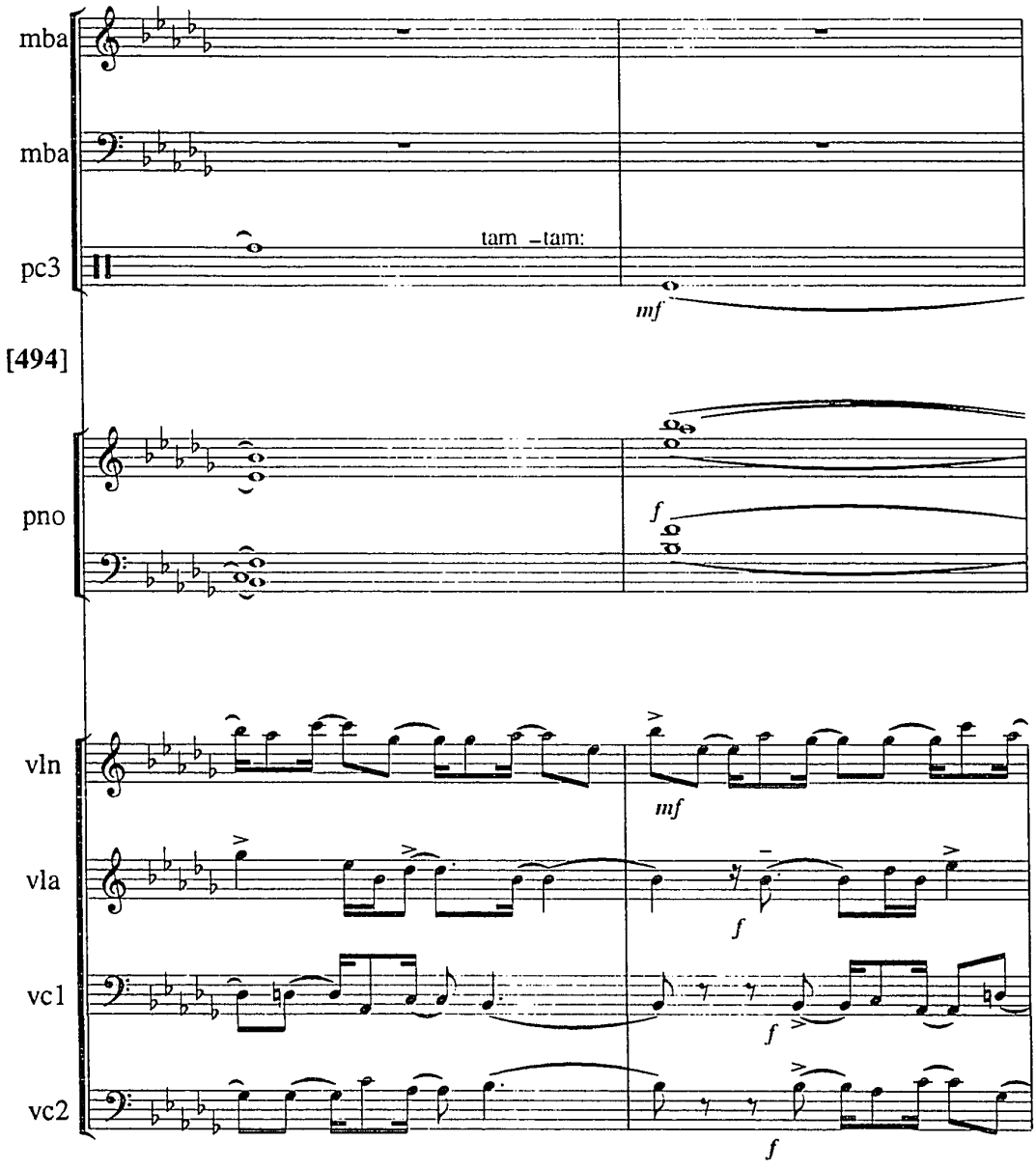

mba
mba
pc3
[484]
8va
mp
pno
vln
mf
vla
mf
vc1
vc2

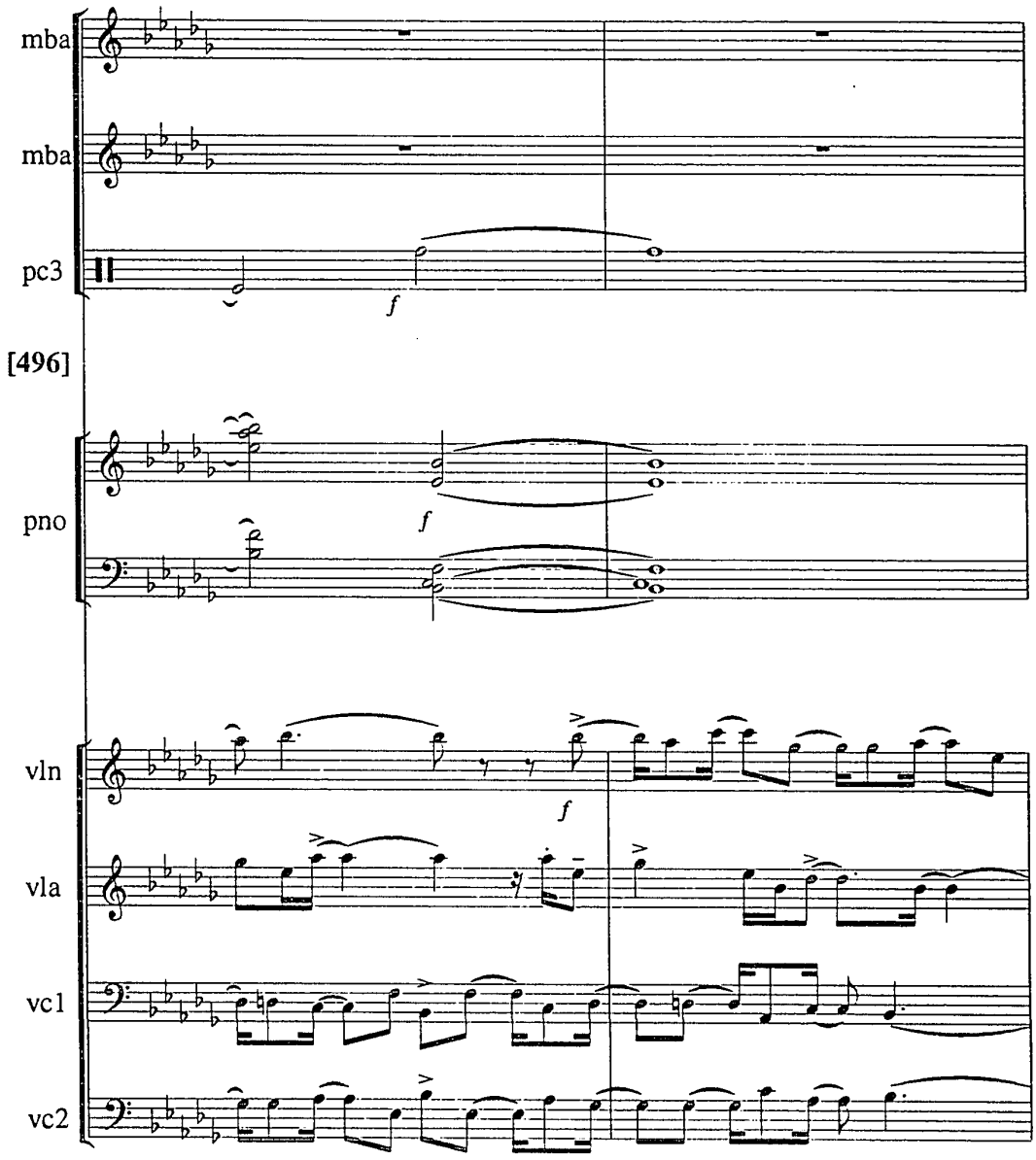

mba
mba
marimba:
mp
pc3
[486]
8va
pno
mp
mp
vln
vla
vc1
vc2
f
f
mf
f
mf
f

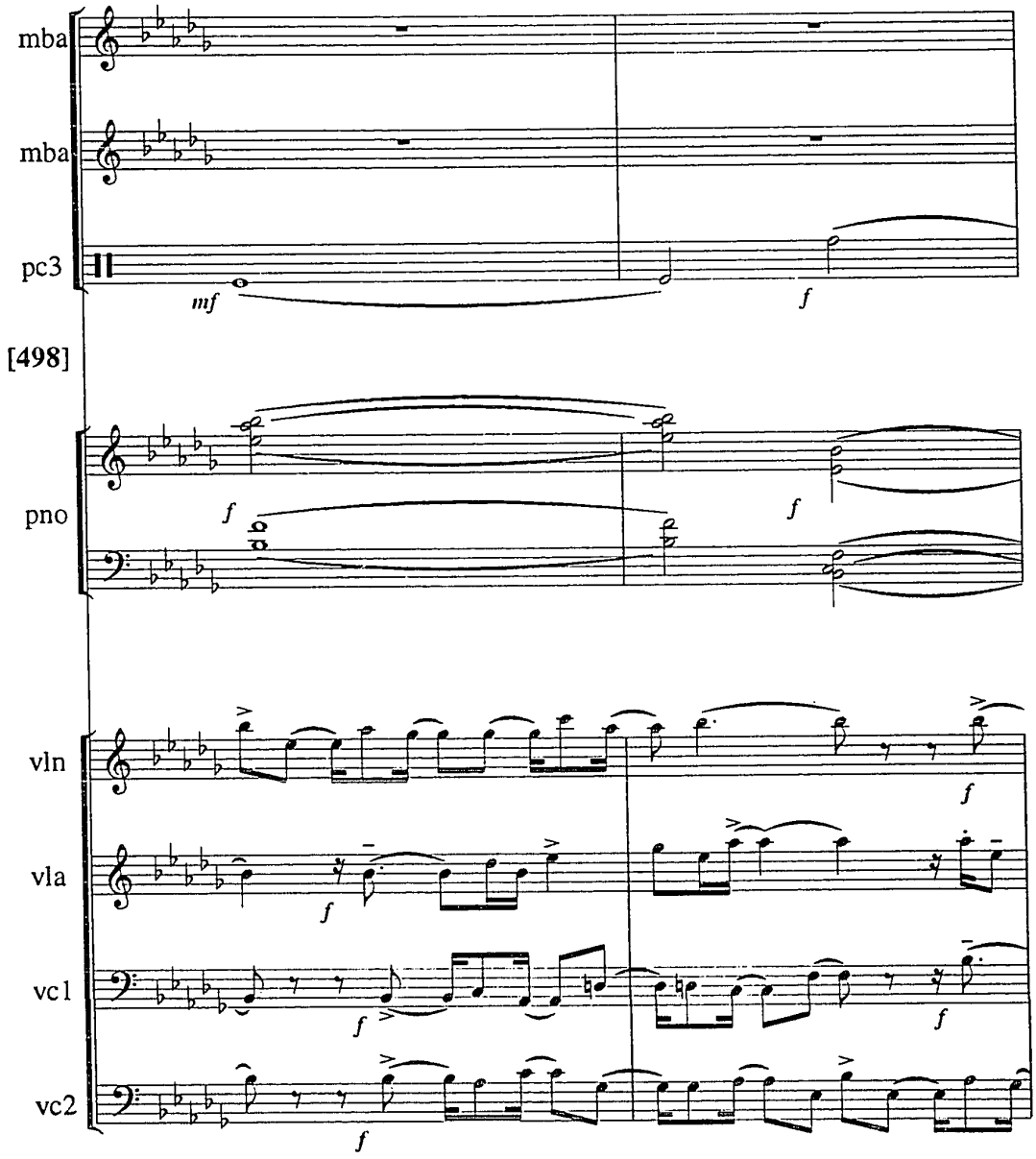

mba
mba
pc3
[488]
pno
mf
vln
vla
vc1
mf
vc2
mf

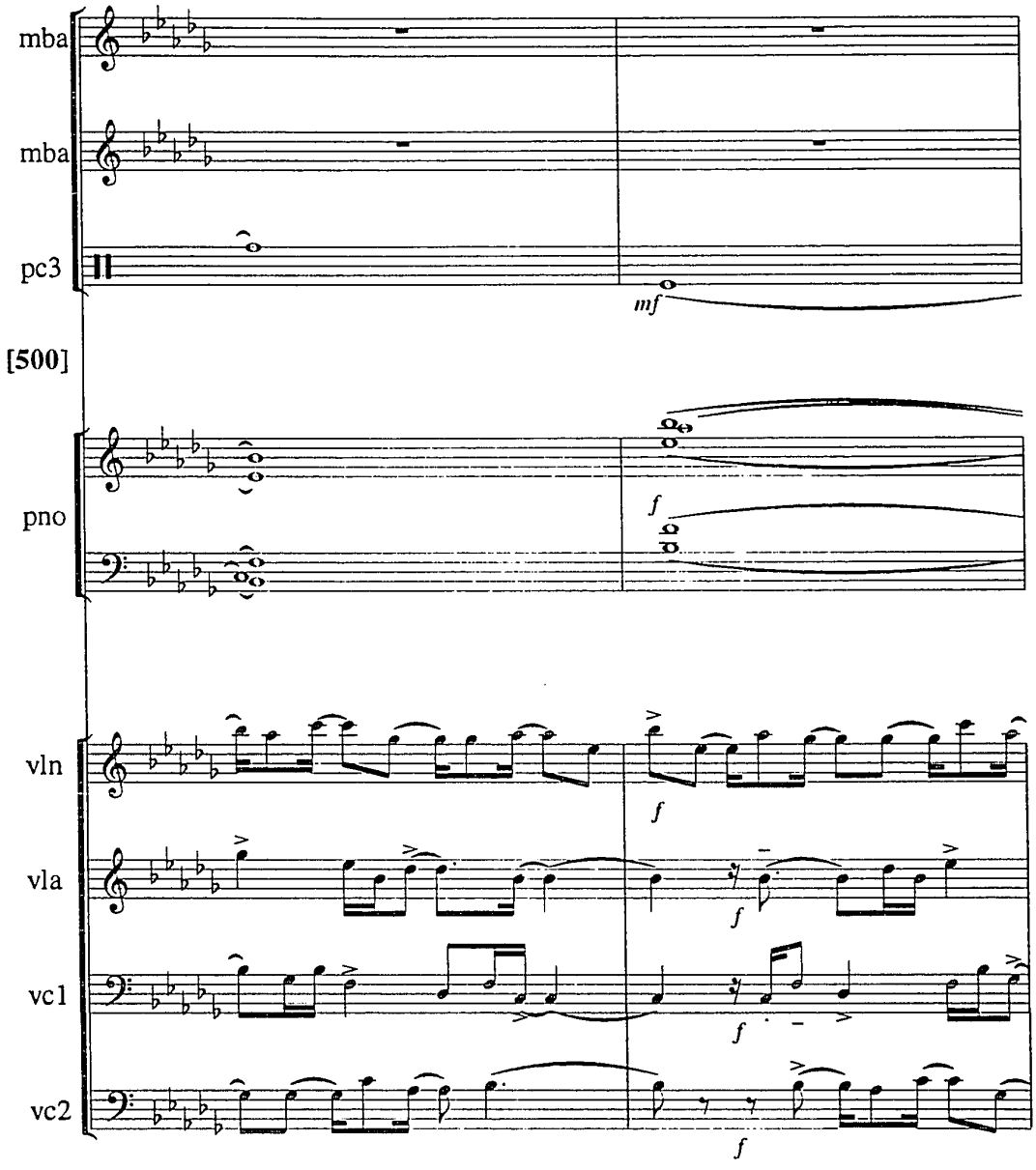

mba
marimba:
mf
mba
pc3
[490]
8va
pno
mf
vln
mf
vla
mf
vc1
vc2

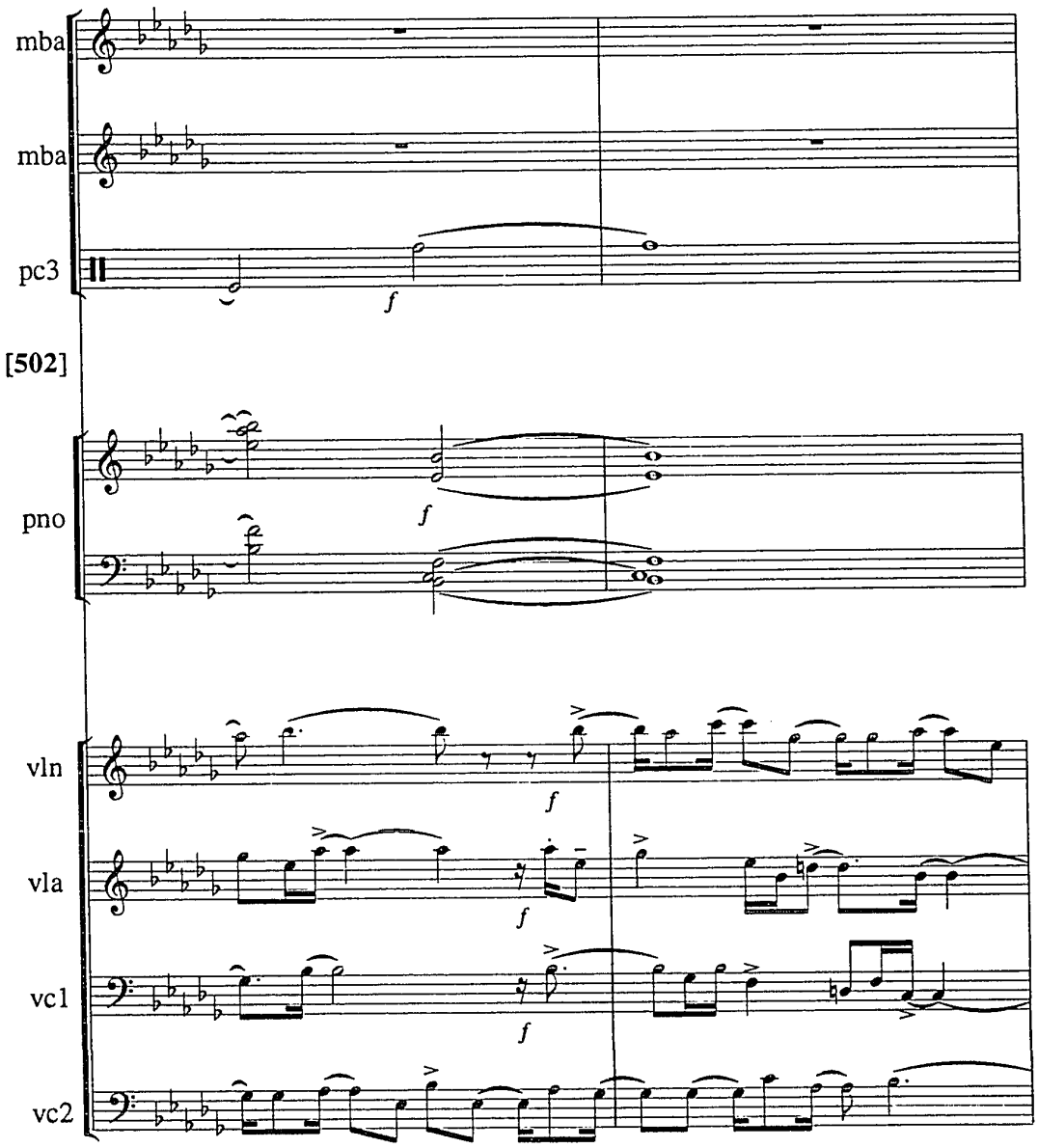

mba
mba
pc3
triangle:
f
[492]
pno
f
mf
vln
mf
vla
f
vc1
mf
vc2
mf

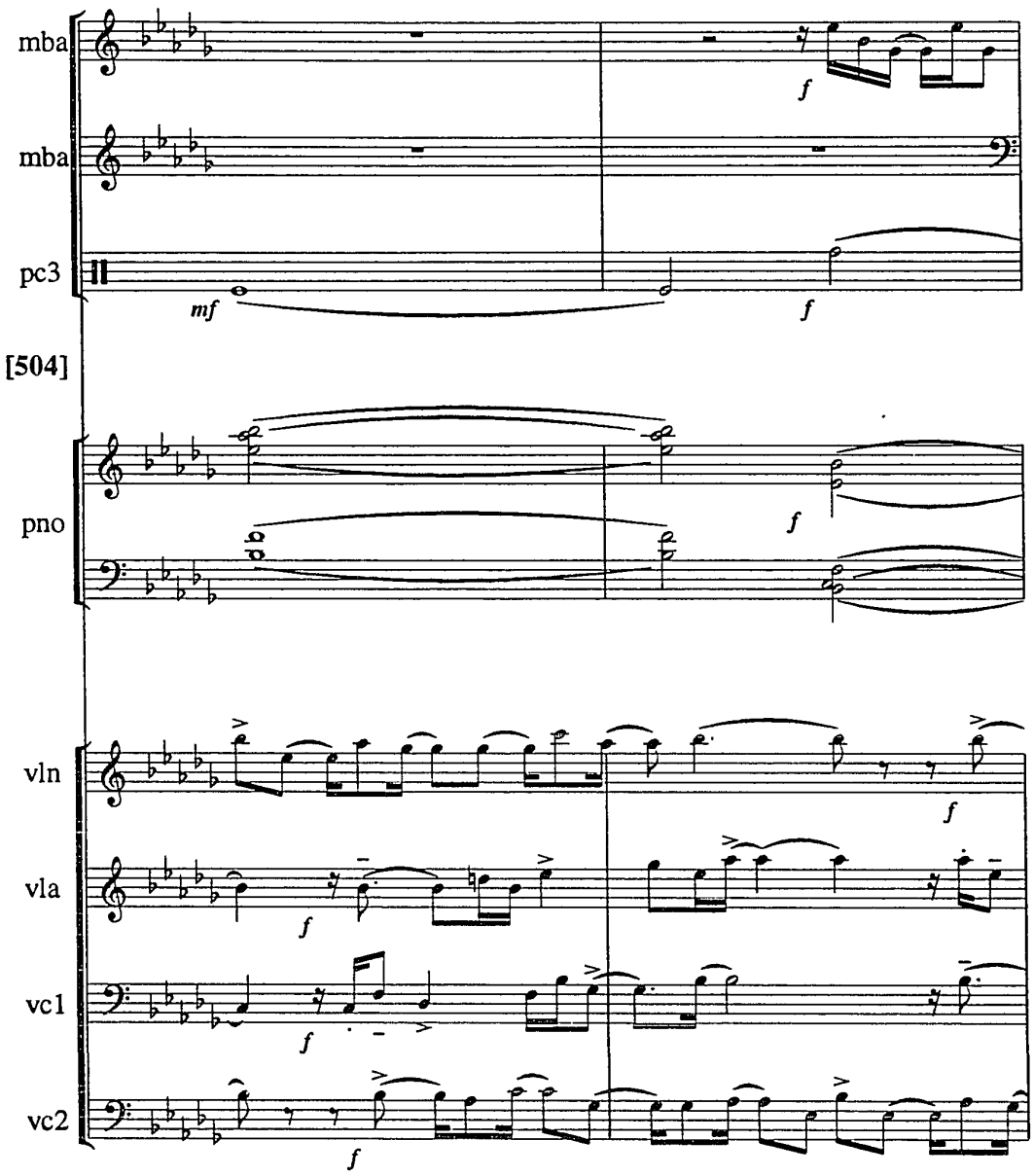

mba
mba
pc3
tam –tam:
mf
[494]
pno
f
vln
mf
vla
f
vc1
f
vc2
f

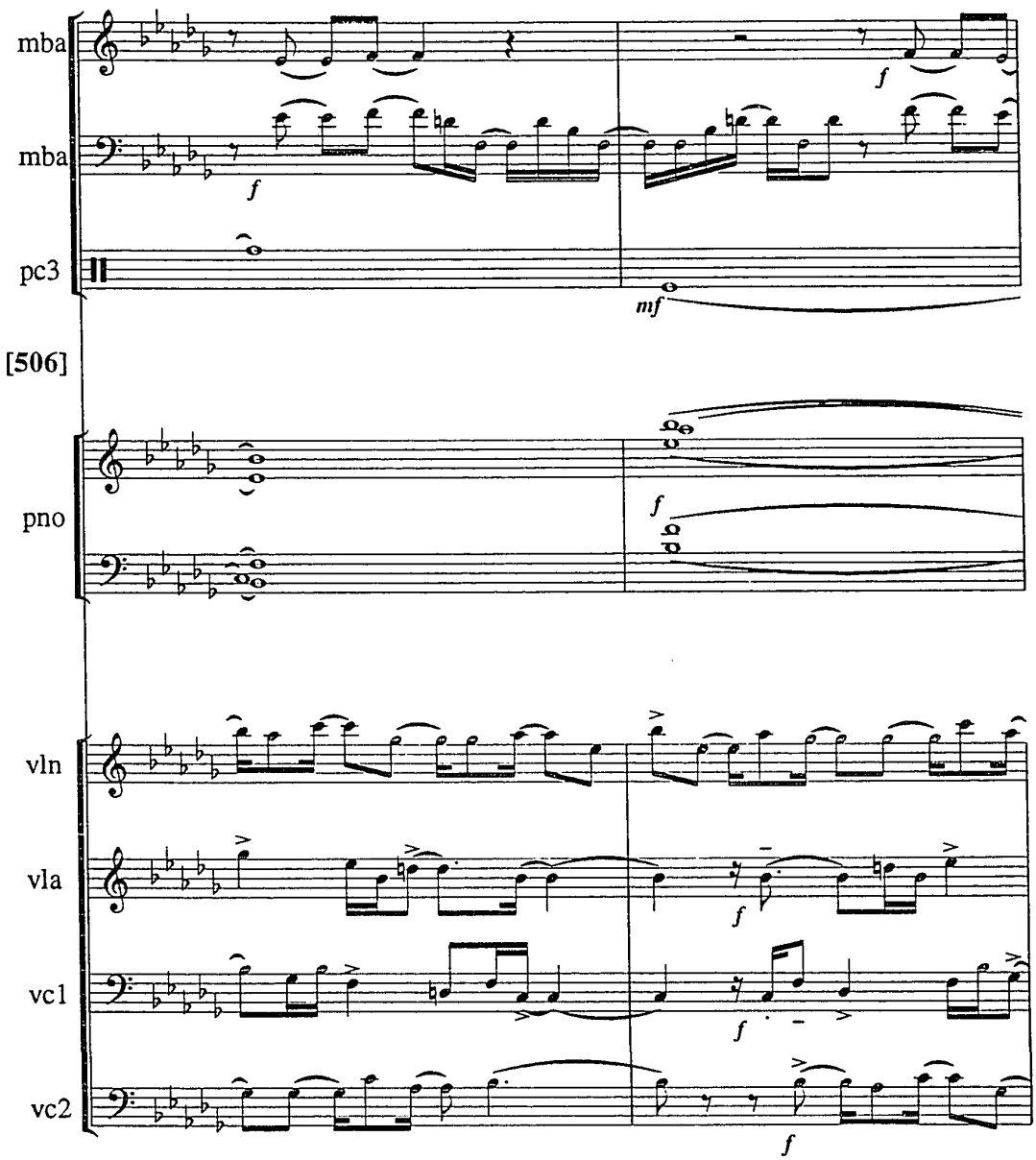

mba
mba
pc3
f
[496]
pno
f
vln
f
vla
vc1
vc2

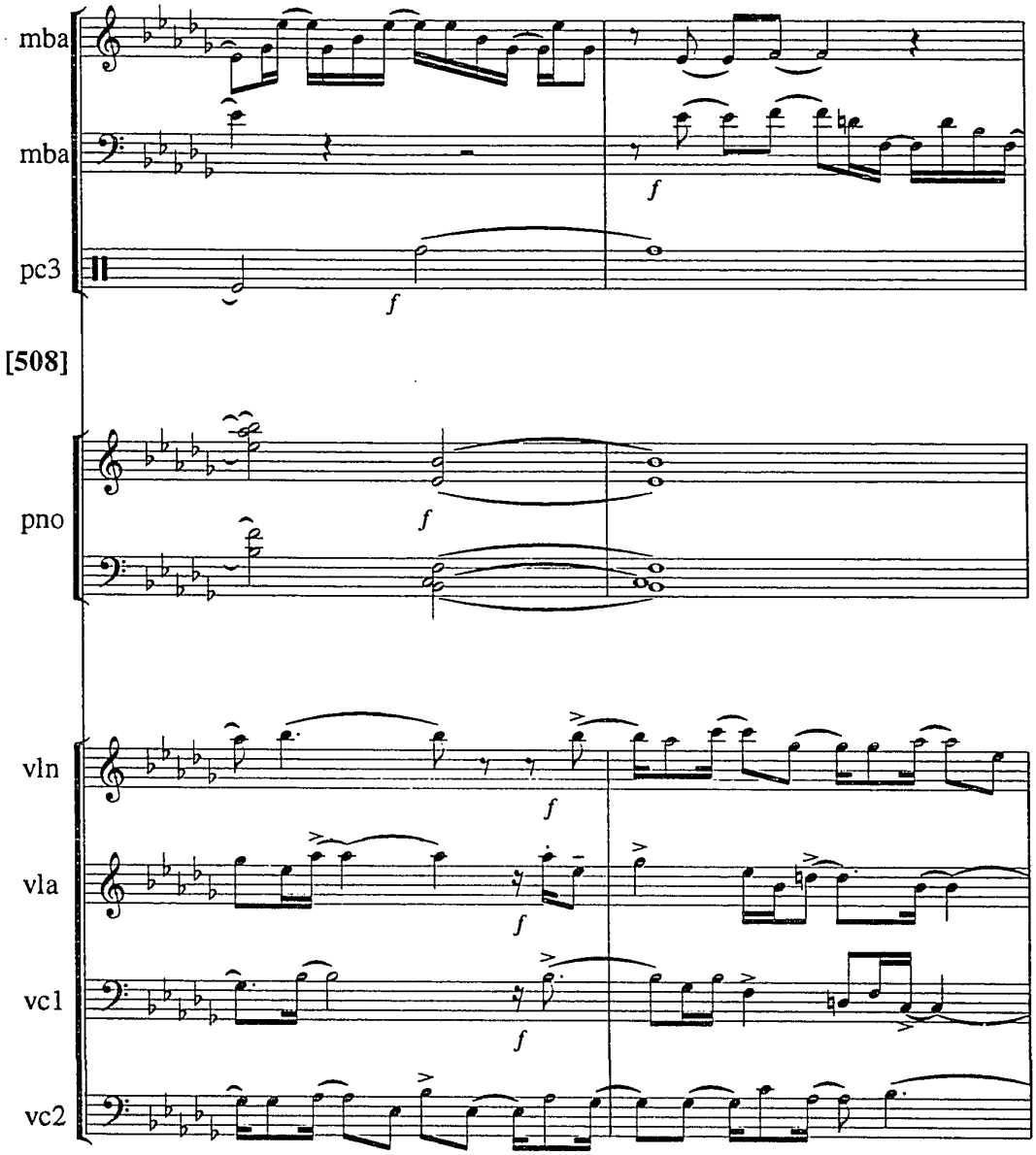

mba
mba
pc3
mf
f
[498]
pno
f
f
vln
vla
vc1
vc2
f
f
f
f
f

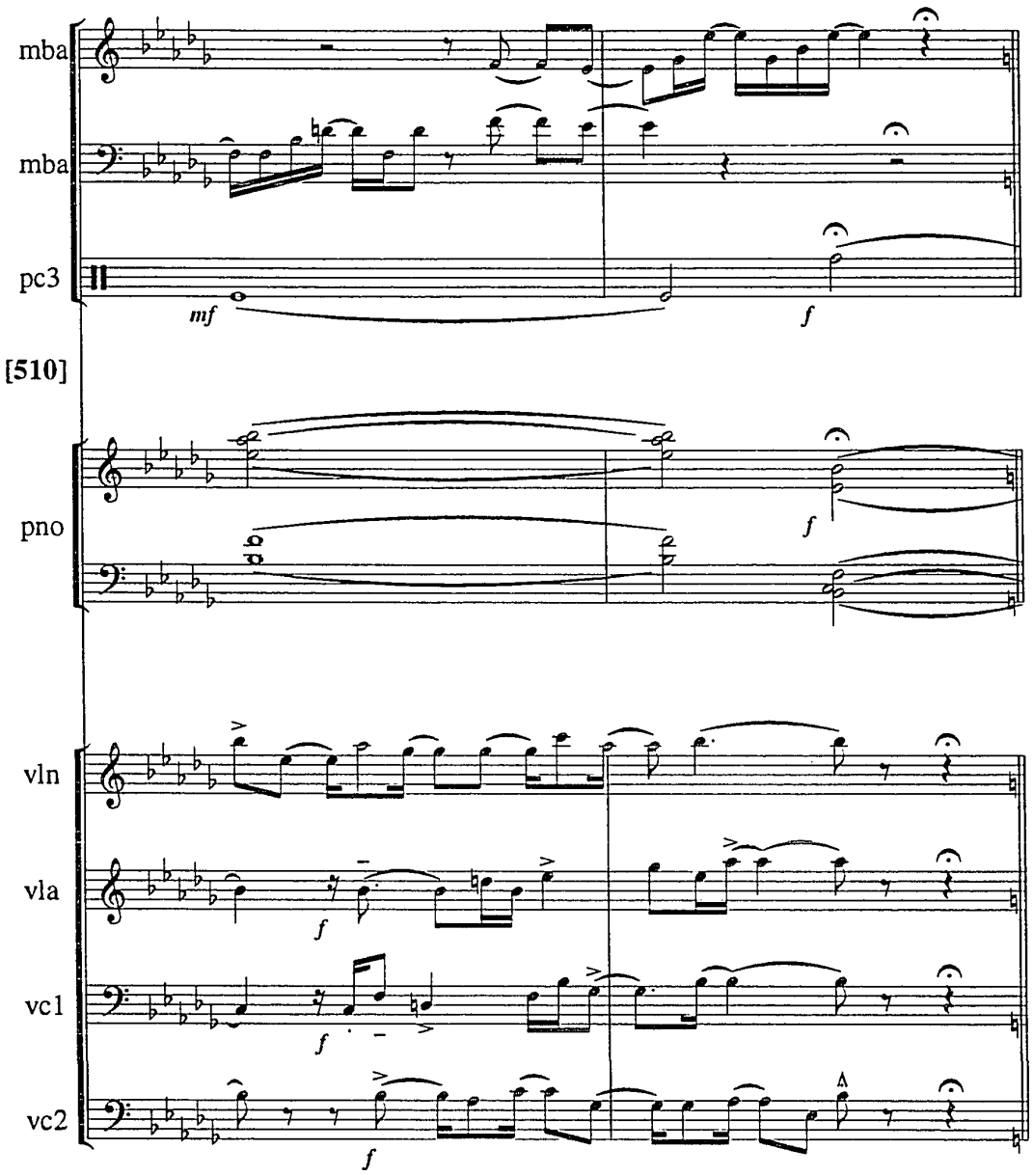

mba
mba
pc3
mf
[500]
pno
f
vln
f
vla
f
vc1
f
vc2
f

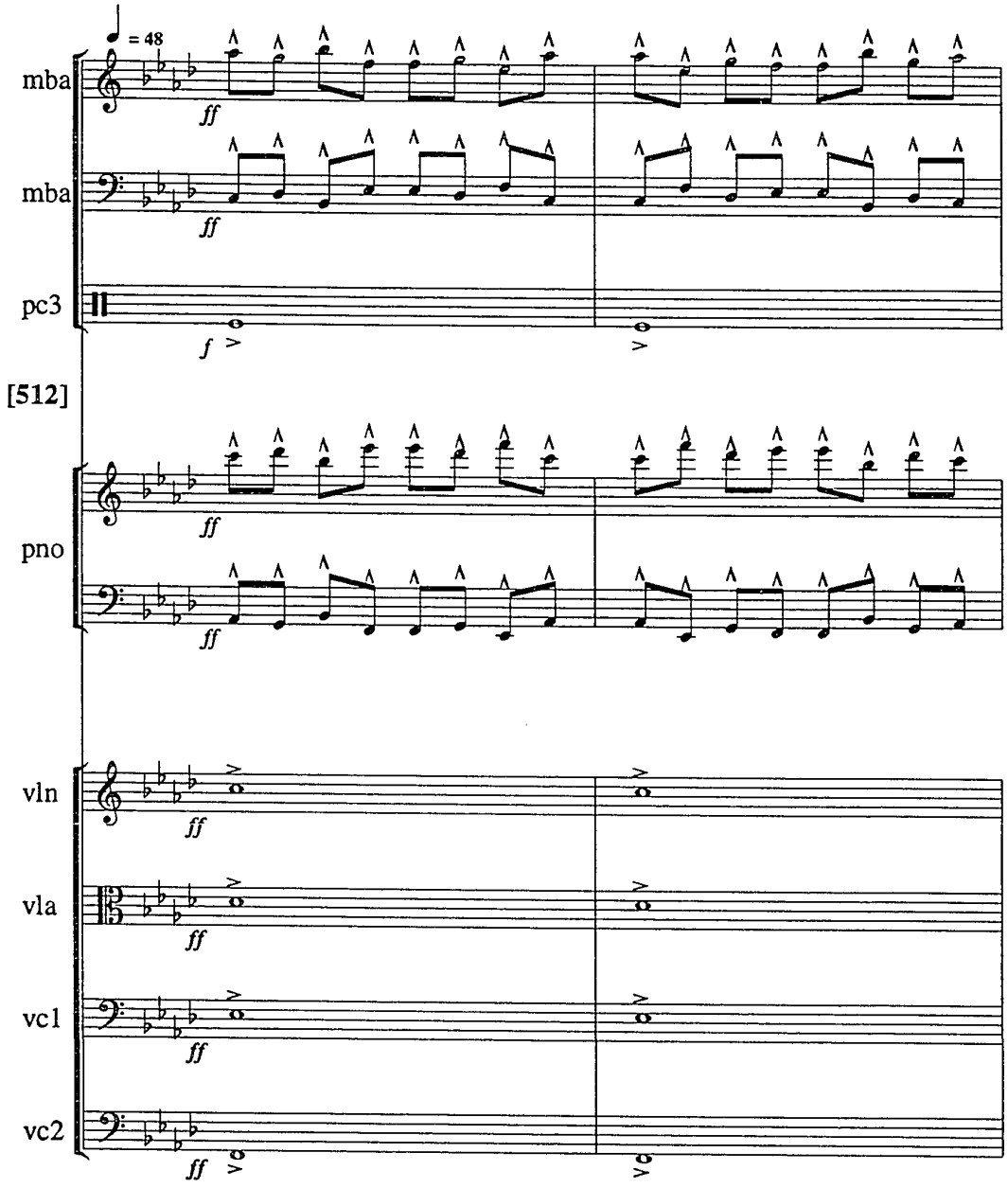

mba
mba
pc3
f
[502]
pno
f
vln
f
vla
f
vc1
f
vc2

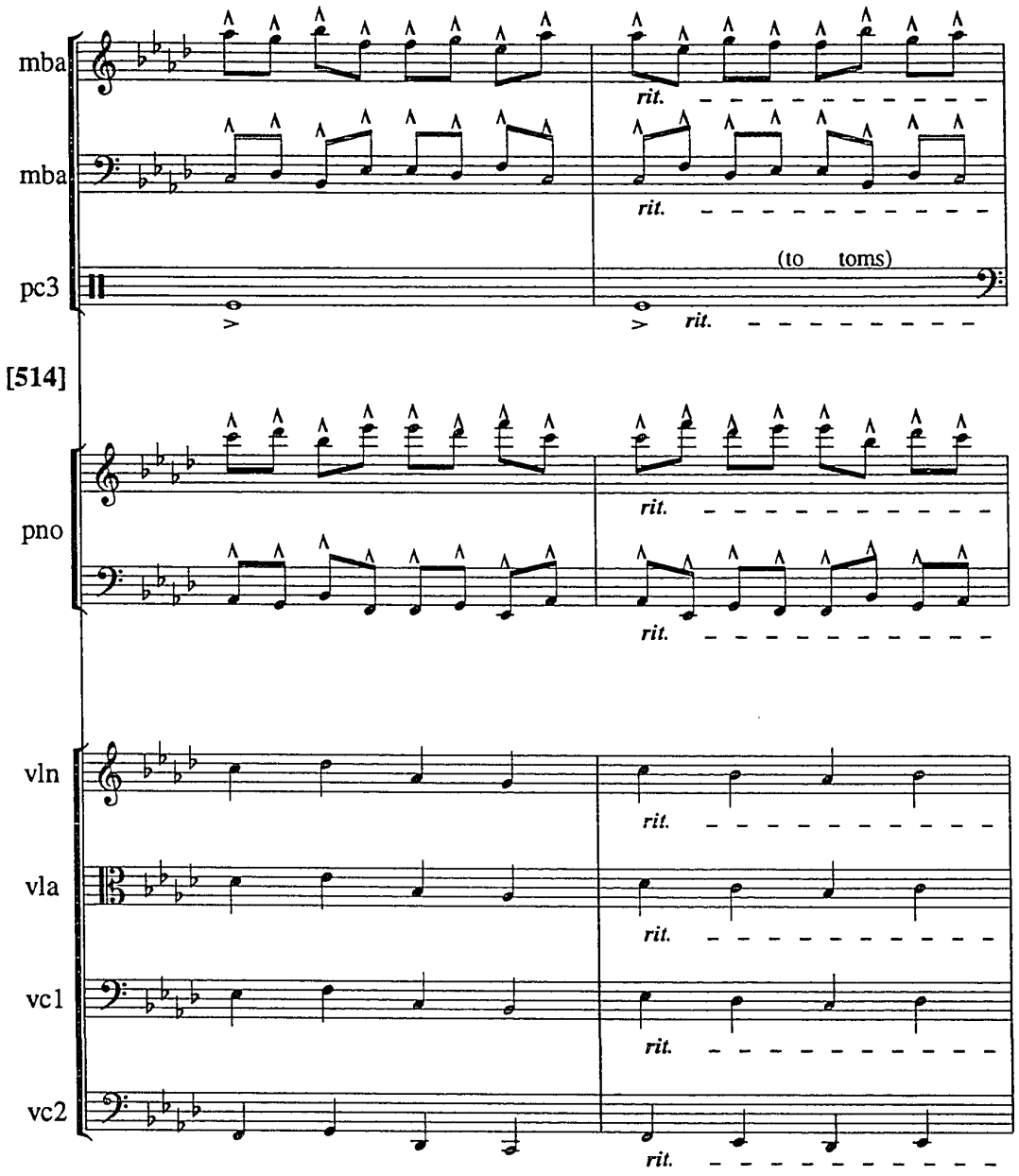

mba
mba
pc3
mf
f
f
[504]
pno
f
vln
vla
vc1
vc2
f
f
f
f

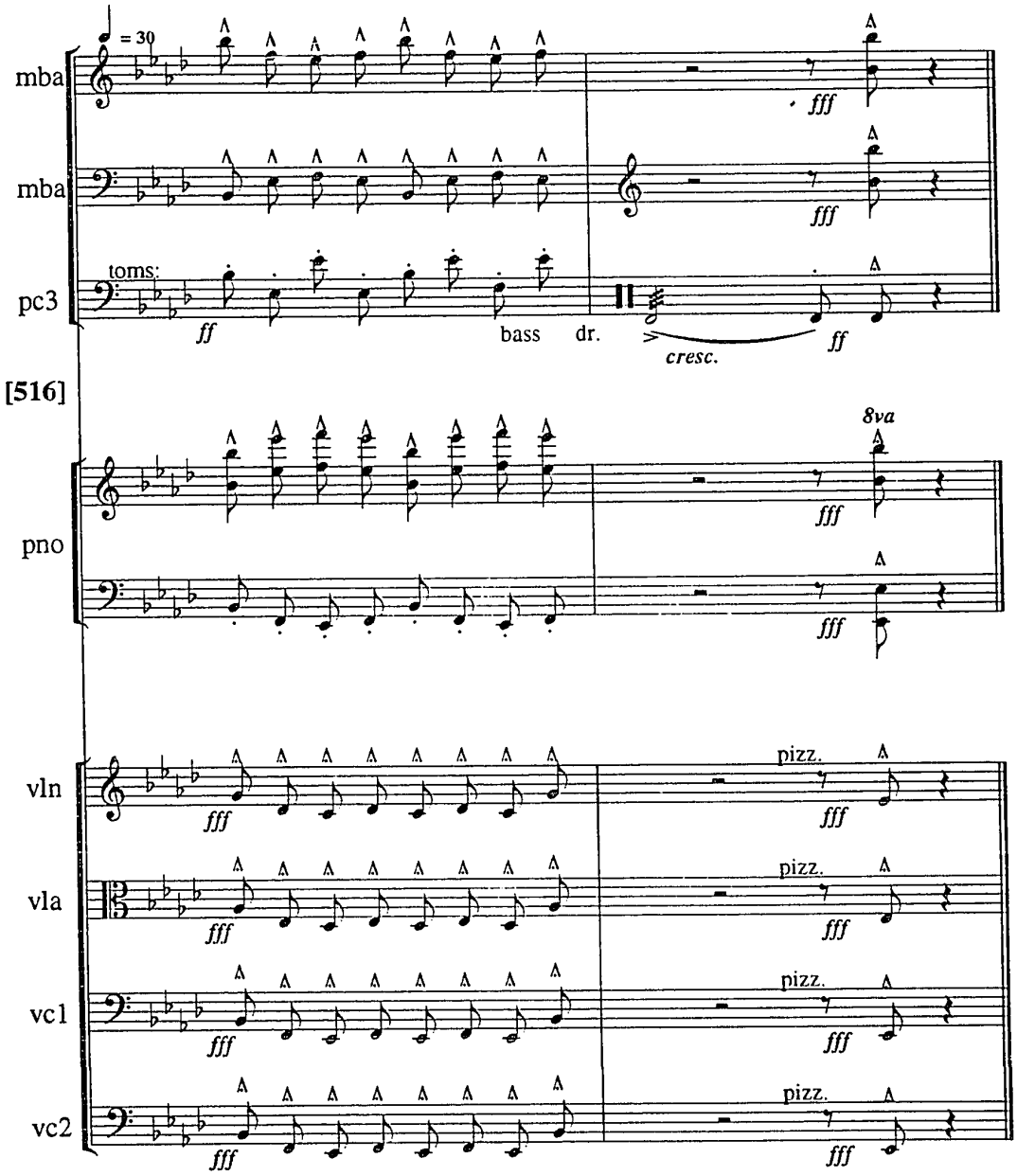

mba
mba
pc3
[506]
pno
vln
vla
vc1
vc2
f
f
mf
f
f
f
f


mba
mba
pc3
f
f
[508]
pno
f
vln
vla
vc1
vc2
f
f
f


mba
mba
pc3
mf
f
[510]
pno
f
vln
vla
f
vc1
f
vc2
f


= 48
mba
mba
pc3
[512]
pno
vln
vla
vc1
vc2
ff
f


mba
mba
pc3
rit.
rit.
(to toms)
rit.
[514]
pno
rit.
rit.
vln
vla
vc1
vc2
rit.
rit.
rit.
rit.


= 30
mba
mba
pc3
toms:
ff
bass dr.
cresc.
ff
fff
fff
fff
[516]
pno
8va
fff
fff
vln
vla
vc1
vc2
pizz.
fff